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The poverty of GIS theory: Continuing the debates around the political economy of GISystems

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Key Messages

- The political economy of existing GISystems must be understood at three levels: the individual educator, the GIS user, and the military-industrial complex.
- We must ask ourselves what kinds of GIS specialists and cartographers we are producing for what kinds of jobs.
- We must not simply write a perpetual near-present; it is necessary to look beyond what data are simply easily accessible in our research.

Over the past several decades, GISystems and GIScience have become established and valorized within the field of geography and geographic education. With the recent explosion in daily use of devices producing spatial data, such as smartphones, has come a renewed call to broaden the purview of Critical GIS beyond the desktop and towards these new systems of capitalist accumulation. In this viewpoint, we argue that any re-examination of the role of Critical GIS must also consider the political economy of geography and geographic education in which GISystems are used for research and taught. We explicate three registers at which GISystems function within geography: that of the individual educator, that of the GIS user, and that of the military-industrial complex in which GISystems were and are developed.

Keywords: Critical GIS, political economy, GIS pedagogy, ESRI, GIScience

La pauvreté de la théorie des SIG : poursuivre les débats sur l'économie politique des SIG

Au cours des dernières décennies, les SIG et la science de l'information géographique se sont établis et ont été valorisés dans le domaine de la géographie et de l'enseignement de la géographie. Depuis l'explosion récente de l'utilisation quotidienne des appareils produisant des données spatiales, par exemple les téléphones intelligents, un nouvel appel a été lancé pour élargir la vision critique des SIG au-delà de l'ordinateur de bureau et vers ces nouveaux systèmes d'accumulation capitaliste. Dans cette perspective, nous soutenons que tout nouvel examen critique du rôle des SIG doit également tenir compte de l'économie politique de la géographie et de l'enseignement de la géographie dans laquelle les SIG sont utilisés pour la recherche et l'enseignement. Nous expliquons trois registres avec lesquels les SIG fonctionnent en géographie : celui de l'enseignant, celui de l'utilisateur et celui du complexe militaro-industriel dans lequel les SIG ont été et sont développés.

Mots clés : SIG critique, économie politique, pédagogie des SIG, ESRI, science de l'information géographique

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Introduction

In an editorial written a little over two years ago, the participants at the second Friday Harbor meeting asked "What exactly is the scope for Critical GIS?" They argued that slippages between traditional conceptualizations of GISystems and new "spatial and mapping technologies" could produce productive tensions for understanding the ways in which the "tools of GIS" have moved beyond "the desktops of state workers, academic researchers, and private sector analysts … [to] become prime sites of speculative investment … and a core means by which individuals navigate and understand the world" (Thatcher, Bergmann, Ricker et al. 2016, 820). In a world where mobile device use produces the yearly output of the Large Hadron Collider in data per week (Dalton et al. 2016), and in which the McKinsey Global Institute has estimated personal location information may generate $600 billion in surplus value per year (Manyika et al. 2011), we agree that broadening the scope of "Critical GIS" in order to leverage its hard won theoretical and empirical insights is a necessary move (Schuurman 2000; Pavlovskaya 2006). As this special issue attests, there is a need to push past where GISystems and GIScience stand and towards what they might, or must if one is feeling particularly emphatic, become; however, in keeping with the original intent of viewpoints to allow for provocative positions (Schuurman 2009), we wish to turn inwards—away from the myriad of dazzling new technologies and data infrastructures that make up a seemingly ever-growing technocapitalist sphere, away from larger discussions of the political economy of space, place, and scale (Sheppard and Barnes 1990)—and towards what a political economy of existing GISystems means for geographers. Specifically, we detail three registers at which the political economy of GISystems may be understood within geography: that of the individual educator, that of the GIS user, and that of the military-industrial complex in which GISystems were and are developed. We will briefly address each in turn.

Throughout this paper, we will use "GISystems" to refer specifically to sets of technological systems that are used for geospatial processing, analysis, and visualization; "GIScience" for the scientific discipline; and "GIS" as the oft-used vernacular confluence of both.

The role of the educator of GISystems

According to a recent ranking by *U.S. News & World Report*, cartographer was ranked as the best overall job within the field of Engineering, 17th in all STEM fields, and 45th amongst all jobs. As is often the case with such reports, and ignoring for a moment that a GIS analyst is not necessarily a cartographer who is not necessarily a spatial data scientist and so on, the news made its way through our network of geographers on social media—some earnestly crowing and others somewhat sarcastically snickering. The idea that an increased "demand for accurate maps, especially across web-based platforms" will drive job growth doesn't seem terribly far-fetched given the recent moves by tech giants like Uber to join the proprietary mapping game (*U.S. News & World Report* 2016; McClendon 2016). While the amorphously defined "cartographer" ranked first, it did so in the Engineering category; conversely, "geographer" ranked ninth in the Science category. These rankings should hardly be taken as gospel, and GIS has been and will continue to be taught in many contexts both within and outside of disciplinary geography (Bearman et al. 2015); they do, however, suggest a shifting relation between the political economic incentives that drive GIS to be taught vocationally (Whyatt et al. 2011) and the technological and employment landscapes that GIS students enter upon completing their education.

On one level, a host of research has suggested that the types of critical thinking involved in geographic information analysis and visualization are useful in a variety of disciplines and employment situations (Janelle et al. 2009; Tate and Unwin 2009; Bearman et al. 2016; and elsewhere). On another, it is impossible to deny that GIS courses are often used within departments to attract students with the promise of a clear pathway to a comfortable, secure, and growing career. While journals like the *Annals of the American Association of Geographers* have recognized GIScience with its own sub-section ("Methods, Models, and Geographic Information Science"), undergraduate classes are often focused far more on professional training with GISystems for future employment than they are with some of the core underlying concerns of GIScience inquiry. Leaving aside the pedagogical reasoning and value behind said course construction, there are

underlying political economic forces that drive this focus on and valorization of particular sets of GISystems.

The rise of GIS in geography can be read directly in line with the neoliberalization of the university (Longley 2000; Smith 1992). At a time of decreased funding and an increased emphasis on graduate employment outcomes, the growing geospatial information sector offered a clear path towards securing funds and attracting students. However, geography students have "never been central to the development of GIS"; rather, geography graduates tend to be employed "in the application and/or marketing of GIS rather than system development" (Longley 2000, 39). Within our discipline, GISystems are taught predominantly as tools to be used, not to be created. While GISystems provide geography the ability to process the increasing swathes of digital spatial data, they too often do so through systems which reify the very "view from nowhere" mappings that critical engagements with GIS were meant to call into question (Haraway 1988; Dodge and Perkins 2009). While this type of formalization of space served a strategic and tactical role in the legitimization and valorization of GIScience within the university and funding systems (Thatcher, Bergmann, and O'Sullivan 2016), and Critical GIS scholars have long been aware of and questioned the limitations GISystems place upon the representation and inquiry into space and place (Sheppard 1995; Curry 1998), the very successes of the "medium of GIS" within geography have, at times, pushed aside alternative non-Euclidean and relational inquiries into spatial relations and ontologies (Longley 2000, 40; Couclelis 1999; O'Sullivan et al. 2017).

Regardless of the very real theoretical and empirical questions surrounding the teaching of GISystems as tools to be used, not created, there also arises the question of the vocational promise implicit in many modern GIS certificate and other secondary programs. In 1995, Pickles asked "what forms of change and what kinds of distortions" would arise within the discipline of geography as it attempted to "retain a central role in this emerging 'profession'?" (1995, 4). Today it is necessary to ask if that "central role" still (or ever) existed. Cartographer may be a "hot job," but are the students produced by our programs what is meant by "cartographer" today? Just as GIS rose to prominence within the discipline alongside the neoliberalization of the university under Reaganism/Thatcherism, we now face a new set of neoliberal pressures on research and educational outcomes.

The role of the trained GISystems specialist

The vocational promise of GISystems as a secure, upwardly mobile, middle-class career path rests upon a series of assumptions by both educator and student. As educators, instructors can be prone to promoting the utility of GISystems skills to an extreme; for example, as a student, one author's instructor suggested that GIS skills would ensure interviews, regardless of job position, due to the massive upswing in geospatial data analysis and visualization. These sorts of assurances are certainly tied to a department's growing need to attract and keep students within tightening university funding systems; but, we argue they also rely upon specific understandings of what it means to "do GIS," both now and in the future. In other words, they rest upon a growing disjuncture between the broad-based critical thinking skills that are promised, the GISystems skills that end up predominantly being taught, and the shifting nature of the technological skills desired for the "hot jobs" in the geospatial information economy.

"Critical spatial thinking" has become something of a hallmark for explaining the importance and utility of education, both of GISystems specifically and more broadly within geography. With respect to GIS, Goodchild and Janelle (2010) find its importance in the social sciences and humanity more broadly, Wilson (2015) finds a vision for it resurfacing at Harvard, and Kim and Bednarz (2013) have demonstrated an empirical correlation between higher levels of education and familiarity with GISystems and improved performance at critical spatial thinking tasks. While the specific vision for and definition of what constitutes "critical spatial thinking" may differ in these and other cases, its role as the interdisciplinary, pedagogical outcome of education in GIS remains; further, the ability of GIS to, supposedly, aid students in thinking across the specialized subdomains found within geography further ensconces it within the discipline (Kemp et al. 1992).

And yet, the vocational promise, and related pedagogy, leads to many existing GIS courses focusing more time on the specific technical skills

of using a given suite of software than on "developing the theoretical understanding of spatial problems, the science behind it . . . and the usefulness of spatial data" (Bearman et al. 2016, 395). Our intent here is not to suggest that only critical social theory is appropriate for education within GIS, as we're well aware of the dangers of using the word "critical" to demarcate forms of science and research (Dalton et al. 2016), nor is it to critique the pedagogy involved in the more vocational teaching of GISystems (Whyatt et al. 2011). Rather, our intent is to highlight that leap between the educational promises of "critical spatial thinking" and the vocational realities of courses which emphasize methods and techniques within specific GISystems. Despite 20-year-old cries for the "hard work of theory" (Wright et al. 1997; Pickles 1997), there remains a poverty of critical theory within many GIS courses. From a vocational perspective, this makes sense. It is more concretely important that a GIS analyst for a given municipality knows how to create a buffer around all wetland polygons than it is that they understand the social construction that goes into making those wetlands recognized by the state or not (Robertson 2006). On one level, it is ethically responsible of instructors to prepare their students, and their likely debt loads, for an actually-existing job market. But, on another, this focus can elide the very ways in which the ontologies of GISystems have always-already reduced the politics and epistemologies made known and practiced through them.

Without further explication and critique, it is somewhat facile to say that every ontological commitment requires some act of epistemic violence, a closing-off of what can be known and what can be done (Braun 1998; Spivak 1998), but in the case of actually-existing GISystems, this observation suggests a key component of GISystems' political economic valence within geography. Where Gahegan (1999, 203) somewhat facetiously quips that "GIS saw to it that geographers became the slaves of the computer, having to adopt the impoverished representational and analysis capabilities that GIS provided" in exchange for funding, sleep, and prettier results, O'Sullivan (2006, 789) more seriously notes that he finds it "hard to see how the technology can empower anyone not already empowered," due to the costs for purchase and use. On the one hand, the current generation of GISystems have greatly increased their representational and analytical capabilities while, in many cases, lowering their costs of use; on the other, a very real "technocracy" still dominates the world of geospatial information and technologies and what can be done and known with and through them (Obermeyer 1995). The "geospatial economy" may always be growing and, certainly, that is a core means by which new spatial and mapping technologies valorize themselves (Leszczynski 2014), but that doesn't mean that all skills (and thinking) are valued equally within it.

This, then, returns us both to the concept of cartographer as a "hot job" and to the possibility of geography maintaining a central role in the education of those who perform said job. According to the American Association of Geographers' salary data website (which is based off of the North American Industrial Classification System and data from the Bureau of Labor Statistics), there are sharp differences in remuneration between the types of work done with a GISystem. Cartographers "[m]ay work with Geographic Information Systems (GIS). May design and evaluate algorithms, data structures, and user interfaces for GIS and mapping systems" and had a medium salary of slightly more than $60,000 in 2014 (AAG, n.d.; all values in USD). In contrast, Geospatial Information Scientists and Technologists are responsible for "research[ing] and develop[ing] geospatial technologies," and "[m]ay produce databases, perform applications programming or coordinate projects." This latter position, with its emphasis on the production of databases and applications programming, had a median salary of slightly over $80,000 in 2014 (AAG, n.d.). Specific job titles will vary across institutions and these figures are not meant as definitive statements on what is worth teaching; however, the differing salaries do suggest that certain skills remain more highly valued in the vocational job market to which GIS education promises access. Namely, the abilities to create and manage databases and to program applications appear to increase salary over the base ability to "research, study, and prepare maps."

The historical-material context of GISystems

As Longley (2000) noted in response to Pickles (1995), the degree to which geography ever played a central role in the production and design of

GISystems is questionable, or, as Gahegan (1999, 204) more lightly puts it, "[i]t is entirely possible that computer scientists invented GIS out of spite" to kick geographers off of their CPUs. Despite this, GIS is taught in a vocational register that, at times erroneously, presumes that behind every map lies someone trained in GIS. Such a view overlooks both a history of technological change within GISystems, and a continuing socio-technical regime which (still) benefits those already in power. The GIS practitioner, as produced by geography programs, is one node in a vast socio-technical system of developers, partners, users, and collaborators, through which spatial information is organized and shared. This system is a vastly uneven terrain of power, exclusion, and capital in which pedagogical ideals of critical thinking are adjacent or even in conflict with its continued function. Instead, imperatives of profit-seeking continue to favour large corporate uses of GISystems over those of individual users. This focus is reflected in the continuing alliances between corporate GIS creator, corporate GIS user, and governmental agencies that mirror shifting relations between state and market found throughout ongoing forms of neoliberal governance. Within the United States (US), the Environmental Systems Research Institute (once known as ESRI and now branded under Esri) and other spatial information corporate actors have particularly concerned themselves with the neoliberal governance of "national security."

In 2012, Esri transitioned ArcGIS into a software platform amongst the hype and hope of other technology industries seeking to find ways to monetize the diversification of information flows in the digital economy (Olma 2014). Part marketing hype, this transition "further integrate[d] desktops, servers, mobile, and web applications" promising a holistic ecosystem in which "[a]ny GIS resource—including maps, imagery, geodata, and tools—can be delivered as a web service"; further, the new "platform" allowed businesses to build their own custom applications using a Software Development Kit available for Apple, Android, and Windows phones (Esri 2012). As a "platform," ArcGIS is meant to enhance the GISystem's communicative function by promising users greater ease of access to spatial tools and data, and by offering the means to share and collaborate with those working outside GIS departments. It is a key moment in the broadening of a GISystem from the analysis and production of spatial information into a more generalized system for creating and capturing value via the control of flows of information and (internal to the system) software development (Beltz Imaoka 2016). The highly valued skill of "applications programming" discussed in the previous section is standardized within the ArcGIS platform's ecosystem. The platform itself becomes a business model for use by other corporate actors and the state. In an Esri white paper entitled "GIS Platform for National Security," the company courts national security agencies and stakeholders with promises of the ability to analyze and access data to prevent, mitigate, respond to, and recover from threats to the US. Esri's products are marketed as an essential component in the "business of securing a nation" (Esri 2014, 1).

The history of entanglements between state security apparatuses and cartographic analysis dates to the very emergence of analytical cartography as a field (Clarke and Cloud 2000; Monmonier 2002). However, the intimate involvement of digital corporations in providing security solutions to problems traditionally handled by the state, such as responses to global conflicts and natural disasters, is part of the expansion and rapid privatization of global security industries following the terrorist attacks on New York on September 11, 2001 (Klein 2007). Google, which handles projects once administered by the CIA, still functions as the means through which information becomes accessible and valuable in the global economy (Parks 2009). Intellectual property, previously classified as a public domain, is compiled and made accessible to the public as a privatized database through such interfaces as Google Maps or Google Earth. Despite the much-hyped democratization of access this supposedly allows, "the most effective mapping and imagery, in terms of coverage, scale, positional accuracy and currency, has been, and often still is, the exclusive preserve of the military, and the strategic advantages this brings have been jealously guarded by those in power" (Perkins and Dodge 2009, 547).

Within the past decade in the US, spatial information corporations that own and operate satellite and computer technologies have assumed responsibilities for spatial imaging previously held by the state, albeit still under the watchful eye and contractual obligation of the Department of Defense. For instance, the commercial satellite, GeoEye-1, launched from Vandenberg Air Force base with

Google's logo plastered upon the side of its Delta II launch rocket and with the corporate giant retaining exclusive rights to the high-resolution imagery it generates (Shankland 2008). GeoEye Inc. had offered its first public shares for sale two years prior, in 2006, in response to expected market growth and in order to more directly compete against its main competitor, Digital Globe. As a publicly traded company, half of GeoEye's revenue at the time remained from contracts through the Pentagon's National Geospatial Intelligence Agency, which maintained primary access to reconnaissance and imagery and denied the highest potential resolution to anyone without explicit government authorization (Dodge and Perkins 2009).

A look inwards, a path forwards?

Where then does that leave us as geographers and GIScientists? GIS emerged during a time of and in response to a specific period of neoliberalizing education, which continues in new forms today; GIS education often takes the form of a vocational promise that may or may not be met by the curriculum it entails; and GISystems themselves are part of large entanglements between the state, corporate actors, and the military. In such dreary circumstances, *what is to be done?*

First, we have purposefully focused on (valid) critiques of the political economies of GISystems and GIS education. An equally valid counter is to point out that *there are alternatives*. We are writing from a North American perspective and, specifically, from one rooted in the US. Similarly, our focus on Esri's role in education and its relations with the military-industrial complex also make sense given their dominance within those sectors; further, it's worth noting that even start-ups like MapBox have received CIA funding within this context (Fang 2016). However, GISystems and GIS education are not monolithic, and the neoliberal hegemon we have described is not everywhere and at all times. For example, new programs like Eastern Washington University's Master's program in Critical GIS and Anthropology suggest new opportunities to blend critique, theory, and methodology in ways outside of those found in traditional certificate programs. Student-led conferences like Resistance GIS build from the traditions of public and participatory GIS to explore new ways of empowering communities and supporting social movements (https://resistancegis.wordpress.com/), while groups like the Anti-Eviction Mapping Project leverage open-source tools like NWU Knight Lab's StoryMapJS to bring powerful spatial narratives of justice to the web (see, for example, the Bay Area Youth Power Map: https://www.antievictionmap.com/bay-area-youth-power-map/). These alternatives exist, and we must continue to seek out and support them while also recognizing, critiquing, and contesting the larger systems in which they lie; for further discussion on revisions to existing GIS pedagogy, see Elwood and Wilson (2017) and Ricker and Thatcher (2017).

Second, with respect to those systems and the socio-technical regimes they produce, we must look to both the past and the future for alternatives. The purpose of this special issue is to gather together voices concerned with Critical GIS, specifically those focused on how Critical GIS might be more constructively engaged by the discipline at large and what it might speculatively become. Like others before us, we caution against throwing out the GIS baby with its bathwater (Warren 1995). But, if there is a poverty of GIS theory, it is a poverty that is born out of a temporal blindness that ignores the deep historical-material roots of GISystems and GIS education. Developing a more robust political economy of GIS, especially as per how it pertains to geography and geographers, requires casting away a series of comforting fictions. We have focused on these three entwined aspects of the existent reality of GISystems and GIS education to highlight the importance of situating GIS within a political economy that functions at multiple registers. Rather than presuming any centrality to the design and development of existing GISystems, we must instead recognize their existence within large sociotechnical functions of the state, military, and capital. As long as GISystems—of any form—have existed, there has been a GIS technocracy; and there has similarly been a need to name and critique it as well.

Finally, while keeping an eye turned towards the past, we cannot become stuck there. The nature of the GIS technocracy, as well as of the socio-technical systems on which it rests, both seem at a particular moment of flux. Over the past decade or so we have witnessed a radical transformation in the ways that we generate, visualize, and share spatial-temporal data. Research has engaged these transformations

along a number of axes and using a variety of terms. From Volunteered Geographic Information (Goodchild 2007) to Spatial Media (Kitchin et al. 2017), these shibboleths have signaled specific focuses, methodologies, and epistemic regimes. But, sitting at the tail end of 2017 and peering (speculatively) forward, we encourage researchers to avoid the trap of researching certain datasets simply because they are accessible. Foursquare was a wonderful tool for researchers, until it wasn't—first changing the terms by which researchers could access their data and, now, no longer existing as an application in its original form. Beyond the dangers of allowing for-profit corporations to control the limits of our research data, we must also be wary of writing a near-present that is no more. The ways that spatial data are generated, accessed, and shared will always change; however, by engaging with the underlying factors that drive said change—such as the political economic ones that we concern ourselves with here—our research will continue to draw from the past, focus on the present, and look towards the future. In that sense, we end on a hopeful note: there is simply so much that must be said and so many potential allies with whom to say it.

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