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Narrow Visions of the Digital Revolution in Mapping: Situating the Canada Geographic Information System from the Perspective of a Feminist Critique of Science and Technology

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In the early 1960s, work began in Canada on what is now one of the most recognizable, , "foundational" computer systems for creating a spatially localized database - containing a variety of social, environmental and economic data - and digital mapping. It was through these maps that economic development decisions were to be made more efficiently and better - the entire program was created with the initiative to introduce improved national resource management practices. The story of this somewhat , "legendary" program has a much broader dimension. This , " improved management" ultimately did not benefit rural development, but it did strengthen the flourishing urban planning, industry and modern concepts related to recreation and leisure. The CGIS allowed for the production of an easily digestible cartographic form that seemed to comprehensively and objectively show the territory being mapped, ultimately supporting the colonial schemes established by white European settlers prior to its development.

Elżbieta Kowalska - Media theorist, designer and artist with a background in visual communication and interaction design. Her dissertation is considering new perceptions and imaginations of time-space-matter, created by data, algorithms, humans and machines, all brought into play in wide-spread and dynamically changing geographic information systems.

Narrow Visions of the Digital Revolution in Mapping: Situating the Canada Geographic Information System from the Perspective of a Feminist Critique of Science and Technology

In Canada in the early 1960s, work began on what is today one of the most recognizable, "fundamental" computer systems creating spatially localized databases with a variety of social, environmental, and economic data, as well as digital cartography. The Canada Geographic Information System (CGIS) was developed based on the ambitious premises of the national/regional government Agriculture Rehabilitation and Development Act (ARDA) of 1961, whose main task was to initiate a wide range of activities for the "appropriate and effective"[1] use of national land. By the power of this document, the administrative Canada Land Inventory (CLI) was initiated, as a direct result of which actions were taken to create computer mapping tools.[2] The official documents' understanding of the productivity and efficiency of this planning approach might be placed in a management practices movement that developed with the beginning of the Western industrialization and another step in digital bureaucratization,[3] facilitating the transfer from hand-drawing maps and archiving data in notebooks to spatial representation in binary code. The basis for this digital medium grew from classification and spatial description practices, according to principles set by engineers, bureaucrats, scholars, and institutions privileged with accessing knowledge and authority in certain networks of Canadian scholarship, industry, and politics.

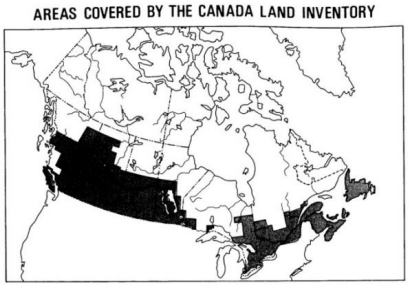

Fig. 1. Planned land survey program area, as of 1970. Illustration based on the official document The Canada Land Inventory: Objectives, Scope, and Organization, "Department of Regional Economic Expansion," 1970, no. 1, 2nd ed. Figure by the article author.

The present article grew out of several intentions. First of all, I would like to stress the significance of present Geographic Information Systems (GIS) for two connected issues: how images of the world are formed and the impact of these technologies on the shape of reality. These tools are less popular than Google Maps or GPS systems—for those unacquainted with the subject this technology is less familiar and rather inaccessible. Understanding their role allows us to perceive the prevalence of GIS tools in various spaces shaping the everyday lives of digital technology users, including the majority of Polish society. Geographic Information Systems were initially designed for functions[4] unlike those provided by traditional European manual cartography or by the computer visualizations developing in tandem. The purely technical definition written nearly thirty years after the first work was begun on CGIS programming, in a work by Michael R. Curry of 1999, goes as follows: "I take geographic information systems to be technological means for the collection, storage, analysis, and representation of geocoded data."[5] This aptly describes the Canadian project.[6] Yet since the mid 1990s many academic discussions have been held to redefine GIS, which points to problems in clearly defining what this system truly is.

The difficulty in capturing and composing[7] GIS comes from the complexity of this device and the contexts in which it functions. Using maps to visualize data—which, to take a New Materialist approach, is not a passive raw material "ripe for the taking," but in itself holds an active, pulsing materiality[8]—has a long and complex history.[9] GIS draws not only from the mapmaking tradition, but also from ways of archiving information,

communication technologies, digitization, computer modeling, and scientific methods. At the same time, in itself it is a tool for creating new data for the purposes of new maps, models, or archives. This is clearly visible in the Canadian computer program. Like its related systems, CGIS was a technological conglomerate using quantitative methods that emerged in the geographical sciences in the early 1970s, along with the development of the capabilities of the first computers, programming languages, and memory storage. We can see from the documentation of ARDA and scientific publications by the project's main creator, Roger Tomlinson, that the CGIS team put major emphasis on the capacity to archive spatial data in "data banks." The map was only one of the program's available functions, but, as the narrator explains in the promotional film *Data for Decision Makers* (1967),[10] it was most vital to hastening the planning process. Its final trim and colorful form was dictated by what was acknowledged to be the proper cartographic standard, the development of cybernetics and communication systems in the Cold War Era, the prevailing systems of scientific classifications, the office work of archivers, researchers' affordances, and volunteers in the field, and finally, what many saw as "raw material ripe for the taking": the dynamic and complex environment of the nation's southern region. Data from thousands of hectares of land were finally to become easily accessible in the form of clear maps, allowing the state reformers to skillfully do their jobs.

As Laura Kurgan writes, the attempt to pin down the origins of GIS or to point to breakthrough solutions that directly preceded the first functioning technology can take many approaches.[11] "Depending on where one starts the historical trajectory, one will end up with a very different interpretation of the meaning and uses of GIS."[12] Groundbreaking solutions are often thought to be the map of the spread of cholera by John Snow, Ian McHarg's overlay method, CGIS, and the American Dual Independent Map

Encoding (DIME) system, yet the genealogy of these tools goes much deeper, and there is far more of them. In examining GIS tools, we ought to abandon all thought of a single, original, and proper precursor or creator of the present highly disseminated[13] technologies. A linear, historical approach does not permit us to conduct an accurate and reliable study on how GIS functions. By the same token, to mark out the "first" solution or the "only true" trajectory of its development is to take the wrong direction, and not only because of the complexity of the research subject. According to Max Liboiron, declaring that a solution, study, or discovery is the "first" in the history of humanity is not only "rarely correct, given the myriad local knowledges operating since time immemorial, but is also imperialist and colonial in nature, using language of priority, exploration, discovery, and uniqueness in a way that erases other people and forms of knowledge."[14] Narratives on the creation of GIS mainly focus on two centers for producing the digital mapping tool, Canadian and American, often pointing to CGIS (created by Roger Tomlinson) as the first working technological solution. These conclusions, however, are based on studies of popularized archives rooted in the American/European context. I myself have no access to sources on other spaces creating these tools, which could be a result of my being in a specific stream of research, language barriers, or a lack of documentation on other histories taking place in other contexts.

The above paragraphs miss a vital aspect of how GIS works in the social space—interactions between the systems and society. As Marianna Pavlovskaya states, GIS is presently used to create new jobs, finance research grants, find information, open university departments and create learning centers, present hypnotic images on computer screens, bolster arguments, and offer effective technological solutions.[15] GIS is less a technological novelty or product than a kind of power relationship. This power is expressed in actions taken through and owing to the medium,

and through its impact on human and non-human relationships, producing new infrastructures and processes in concrete physical spaces. The strength of its impact is directly tied to its situation at the intersection of science, technology, and visuality.[16]

My next aim is to point to those elements of the story about the creation of the Canadian Geographic Information System that are consistently ignored in the popular narrative. CGIS is an essential case study, and one that will let us see how the mass production of an easily assimilable cartographic form, which appears to offer a complex and objective map of a territory and its characteristics, ultimately supported its creators' narrow socioeconomic vision, resulting in concrete decisions being made for national development. This "better management" did not provide the benefits for poor rural areas posited by legislation, but it did work to the advantage of the era's burgeoning city planning and industry, while supporting the implementation of modern concepts of rest and recreation and taming of the natural environment.[17] The relationships between production, distribution, and consumption of goods and services created by this system reinforced an economy based on the exploitation of marginalized societies and environments. Undoubtedly, the development of these technological tools led to a cartographic revolution, but not the kind that would flip the tables of a centuries-long European dominance. This computer program was meant to develop both national and local planning along lines marked out by the Western concept of the modern state and an economy based on industry, capitalism, and the dynamic growth of cities, ignoring whatever was irrelevant to these aims. In the present article I would like to show that the Canada Geographic Information System, developed under the umbrella of the ARDA project, was a useful technological innovation for enabling top-down government control, and also a tool enacting a new iteration of colonial schemata, grounded in the actions of white European settlers that preceded the

system's development. As such, it will be essential to show how the Canadian system of geographical information participated in setting new conditions for the functioning of social, environmental, and economic relationships.

My third intention in this article is to attempt to overcome the approach which sees CGIS digital maps and solutions as holding a significant methodological and epistemic advantage over what might be called analogue practices. The digital mapping tools market is growing at a tremendous speed. As this article is being written, Google Maps is introducing new capabilities for searching and identifying objects in physical locations, such a natural monuments or districts of cities, with the help of smartphone photographs.[18] The swiftly developing Mapbox offers three-dimensional, realistically designed virtual maps that take users into a world derived from video games, and also provides a user-friendly interface and programming language to help create these aestheticized representations and a basic analysis of spatial data. There is not only a wide range of online courses where you can learn to use free QGIS programming or Leaflet.js script, there are also Internet forums full of enthusiasts ready to help others solve their problems. Unlike the eagerly developed cooperation networks, the popular OpenStreetMap service, begun as a grassroots project improved by volunteers, has now mainly been seized by Apple, Amazon, and Facebook,[19] and the war in Ukraine has been seen as profitable by an American remote sensing technologies corporation, Maxar Technologies (formerly DigitalGlobe), which has helped public media and the United States government to acquire high-resolution photographs of bombarded areas.[20] At the same time, we may observe the dizzying speed with which satellite photo databases and digital spatial data archives are growing, from numerical ones to Youtube films.

It seems a social awareness of the ambivalent nature of these phenomena is on the rise. On the one hand, there are new democratic cooperation networks to support societies; on the other, this access increases capabilities for controlling societies and environments, as they are absorbed through consecutive capitalist projects that can reprogram them according to the desires of those who hold power.[21] Using CGIS tools as an example, I intend to show how this fairly early system formed the bases for future digital mapping technologies and how they have affected our perception, understanding, and functioning. I am asking who supplemented the CGIS project archives and how, how they were used, what research methods were used, and to what end. Going a step further, I aim to show how contemporary scholars have tried to overcome the technological limitations of digital geographical information systems in an effort to change computer mapping methods for a more democratic future, one based on cooperation and political compassion.

A Feminist Critique of Science and Technology in the Context of CGIS Research

I am basing my approach on a perspective introduced by the Feminist Science Studies (FSS) movement, which also concords with a New Materialist methodology. FSS grew out of a "critical engagement with the disciplinary norms and institutional contexts that position scientific data as representing unmediated truth about 'the world' and 'the body'."[22] The scholars' many previous years of critical interventions in producing knowledge on the materials, technologies, ecologies, embodiment, gender, and human/non-human relationships over two decades ago began to be included in the wider stream of FSS.[23] This is not a cohesive group—as an entry in the Stanford Encyclopedia of Philosophy of 2020 titled "Feminist Perspectives on Science" demonstrates, adherents of this approach differ in terms of their aims and

epistemic and ontological assumptions.[24] Yet they do share certain core principles. FSS questions both what is considered science and its production. Feminism is "a site for theorizing and reconfiguring the very meanings of science. [...] We propose excavating the diverse and eclectic genealogies and traditions within feminist theories to reimagine what science is and might be."[25]

A feminist critique of science and technology is an important point of departure in studying this Canadian computer device for mapping and data analysis. First of all, it asks us to situate the field of research, to gain knowledge and self-reflection on the relationships between those contributing to its creation. For the purposes of this article, I will mainly be taking three approaches from a feminist science perspective: postcolonial, affective, and new materialist.

A decolonial, feminist, critical perspective means a radical re-evaluation of what is considered science. Colonial settlers in the territory of present-day Canada caused, as elsewhere, a profound devaluation of the "native original."[26] They took control of language, cultures, and bodies of whole societies by force. Postcolonial interventions are less a scientific theory than a set of joined perspectives[27] involving "a process of dependency on the whole colonial syndrome, which takes many forms and is probably inevitable with regard to all those worlds that were marked by that set of phenomena."[28] They showed that science "was not just mobilized in service of colonial agendas, but rather materialized through epistemic imperialism at the heart of colonization."[29] For scientific study, this necessitates revolutionary change in what was and is legitimized as the "proper" state of research, and including practices, methods, and theories that were once considered unscientific, backward, pseudo-scientific, magical, alternative, or indigenous.[30] The application of this perspective in the following analysis means taking into consideration a history

that used violence to exclude the First Nations peoples from the concept, archives, and methods of CGIS, along with the imaginings it created for the country's path of economic development. It means turning attention to histories documenting practices to claim colonized territories and control societies and the ideologies to support the status quo.

Another foothold in our attempt to grasp the logic of how CGIS operates is the affective approach to analyzing visual materials described by Laura U. Marks. An affective analysis may serve to build a grounded and more adequate critique of visual materials in documenting CGIS and CLI programs. I intend to use this analysis on maps available to the public that were created between 1961 and 1978 with CGIS and published on the Canadian government web site (Canadian Soil Information Service, Government of Canada). According to Laura Marks, a critical study of visual representations in science often begins with a formal analysis or leaps directly to a discourse level,[31] giving short shrift to what the representation evokes in the viewer or scholar on an affective level. This may result in a disconnection from essential qualities of visual representations evoked in the body during observations and which are undoubtedly crucial to a reliable analysis. Marks formulates her method in order to "draw thought back to the body," since, as she explains, "we are using our bodies to do philosophy."[32]

Moreover, it is essential to stress the significance of the materials that help make up an immanent characteristic of CGIS—inserting all human actions in the context of the active forces of the non-human, natural-technological, and organic-synthetic. Scholars formulating the bases of a New Materialist perspective stress that in social and cultural practices physical materials the significant—land, places, actors both animate and inanimate.[33] In reality, these materials are not "called upon" to cooperate in formulating a concept, discourse, or project. My attempt to grasp the Canadian system of digital mapping is

based on the above premises, taking into account the essence of the materials that work through and in spite of the system's functions.

The Colonial Technopositionality of CGIS

In creating CGIS programming, a crucial role was played by nongovernmental units and communities involved in the development and widespread implementation of engineering and computer innovations, such as aerial photography, the first more advanced programming languages, and computer equipment.[34] The "father" of GIS programming is thought to be Roger Tomlinson, director of the CGIS project and later an activist for the development of these systems.[35] Back before he began working on computer programming, Tomlinson, a geography graduate, had taken and processed aerial photographs (photogrammetry) for the Canadian Spartan Air Services; with these tools, he vainly attempted to convince the corporations that mattered in the computer industry—including Devices of Canada, and America's IBM and Univac—to work toward creating computer programming and devices for digital mapping.[36] As Tomlinson states, it was a meeting with the CLI project head, Lee Pratt, that led to an exchange of ideas tied to the use of computers in the upcoming land inventory, which, in turn, initiated work on the CGIS program project.[37]

The ARDA regulation was originally meant to stabilize the agriculture and extraction industry, though after a few years its aims were reformulated; thereafter, it was meant to support poorly developed and impoverished rural areas.[38] With this undertaking, the Canadian government intended to organize a theretofore "chaotically managed" sector of the country and gain missing knowledge on their own capabilities and economic development limitations. The aforementioned CLI inventory program was focused on inhabited areas, including those perceived as potentially advantageous for increasing profits.[39]

This is why large swaths of northern Canada were initially omitted[40] (in later years the program these lands were filled in, as maps found on the official government website show).[41] The inventory program[42] covered around thirty per cent of the country's surface area, a region of 2,700,000 km^2. Documents show that this was not strictly a top-down government undertaking—grass-roots initiatives also took part in creating a network of cooperation that joined universities, students, NGOs, private companies, and individuals.[43] Both the CLI and CGIS programs were closely tied: the CLI inventory was meant to create standardized, legible data bases, while the task of the CGIS computer system was to facilitate ways of visualizing in digital maps much faster than human manual ones.[44]

CGIS was meant to facilitate management, providing a visual representation of space, simplifying the process of making decisions about the future of the country. The map used for this purpose served to depict values primarily tied to economics and the country's economic future. The program's development came at the time of transfer from a mainly agriculture-based economy to the intensive development of industry and urbanization.[45] As Shannon S. Bower states in her detailed analysis of both projects, in CLI and CGIS the administrators' visions of Canada's past and present were rendered clearly. They believed the settlement period had passed, leaving behind chaotic and "illogical" decisions over the use of land and distribution of people.[46]

The beginnings of white Europeans exploring and settling the country corresponded with the desire to earn private profits from trading valuable goods—from the sale of fish, furs, and beaver pelts (used for hats that were popular in Europe at the time).[47] While chaos and a lack of logic in land management during the creation of the first European colonies undoubtedly arose from a lack of knowledge about any specific local ecologies, there is no denying the fact that this knowledge was often supplied through a (unilaterally advantageous) form of

"cooperation" with the native inhabitants. The white settlers' negotiations with the First Nations aimed to take over the territories belonging to the locals and gradually exploit the natural environment.

Colonial and racist relations of inequality and dominance were established in various ways. In Canada's case they were highly institutionalized and based on deceptive practices of cultural and social negotiations working to the advantage of the development of the settlers' economy, land management, and planned colonization.[48] These practices led to a vast swath of the country being seized by the newly arriving Europeans from the First Nations peoples, often leaving them only small, strictly parceled regions known as reservations. The subsequent development of agriculture also meant brutally interfering in the native people's lives. As scholar Sarah Rotz contends, Canadian farmers "played a specific role: the land and freedom their communities gained in the 'new world' resulted directly from the dispossession of Indigenous peoples."[49] Continuing this state of things was based, on the one hand, on taking more land, and on the other, on haphazardly creating scattered societies that were now stripped of territorial freedom.

In the narratives around CGIS and CLI there is no mention of the many years of violent actions that set the foundations of present-day Canada; the function arranging the inventory of CLI the documentation mentions[50] indicates this was not the first program to assess the potential of the country's land and the quality of the soil. The history of Canadian land surveys goes back to the latter half of the nineteenth century. The matter of occupying territories in this period and the ideologies behind how the First Nations peoples were perceived and treated has been described in detail by Brenna Bhandar in her *Colonial Lives of Property: Law, Land, and Racial Regimes of Ownership*.

She calls attention to two figures: James Douglas and Joseph Trutch, colonial administrators who differed in their violent intensity and dishonesty toward First Nations peoples.

Though there are numerous examples of attempts to make contact with First Nations people through alliances and cooperation, the native population was the subject of European colonization from the very outset. Beginning in the 1850s, colonialism involved efforts to gain the "official" title of white settlers in the lands of these native dwellers.[51] Governor James Douglas, who took control of the Vancouver Island and British Columbia colonies, had two practices for seizing land. First, having observed the native inhabitants were interested in holding the right to possess their own lands, Douglas decided to buy the land from them first, and then have settlers make their homes there. In this way he sought to avoid the evident anger of the First Nations peoples when their lands were occupied without permission. This principle did not hold in the colony of British Columbia—"reservations" were marked off for the native inhabitants, and the remaining areas could be purchased by both the white settlers and the natives inhabitants. Although the native inhabitants had the right to purchase land, the prohibitive conditions made this an impossibility for most of them.[52] Thus, the principle of equality in trade existed only in theory. Yet the very act of resettlement, the enclosure of First Nations peoples in reservations, stripping them of the possibility of moving about their lands from season to season, was a violent colonial act.[53] Despite continuing practices of taking away cultural and territorial freedoms, James Douglas tried to incorporate native populations into the mainstream of European rule, discriminating against or utterly rejecting the culture and practice of the First Nations, and convinced that these peoples only stood to gain by adopting European civilization. Joseph Trutch, on the other hand,

expressed overt contempt for the native inhabitants, whom he called "the ugliest and laziest creatures"[54] he ever saw.

Trutch was a ruthless colonial administrator, and though many of his peers used violent practices, it was he who cut the reservations in half, in some cases to sizes that barely permitted a basic existence.[55] To this end, he stooped to falsifying official documents that broke previous principles and treatises (including those applied by Douglas's administration), while denying that the First Nations had any right to the lands they had once occupied.[56] As Bhandar writes, Trutch was primarily counting on increasing his own wealth on his "voluntary" but rather unsatisfying move. He believed in "progress" measured in agricultural production and economic development by European principles. To his mind, the "Indian savages" would never achieve a level of advanced civilization; this was proven, he believed, by their incapacity for abstract thought.[57]

The effect of these colonial actions was to produce two strictly divided economies in the country: land and identity, Indian reservations and the private market of individual property.[58] At the same time, the settlers' private market drew from the work of the First Nations peoples, in the fur trade, the timber industry, seasonal farm labor, fishing, and gold extraction.[59] The native economies that had existed before colonization, such as the potlatch, were banned, which additionally impoverished the natives and led to their profound dependency on the new state structure.[60]

Land research into such factors as the fertility of the soil, the presence of minerals, or the characteristics of the climate, served, on the one hand, the planned appropriation by white settlers and the creation of reservations for First Nations peoples, and on the other, the exploitation of natural resources. Reservations were marked out based on field research—the commissioners, governors, and secretaries designated lands for reservations when, in their opinion, they "sufficed" not to incur

the rage and opposition of the First Nations, while keeping the best and most arable lands for the colonizers. All the remaining lands that were not part of the reservations could thus be used for economic purposes and the nation's development. In permitting the protection of certain aspects of First Nations cultures and traditions, "the Canadian state evolved a complex method of assimilation [...] that has proven very effective in securing the land for occupation and exploitation."[61] The consecutive pieces of legislation on resource extraction, which held through most of the twentieth century, were based on a Supreme Court decision in 1888, in the case of St. Catherine's Milling Co. v. R., on whose basis the native people's right to their lands was acknowledged only if this was the will of the Crown, which could be repealed at any moment.[62] Various practices controlling the presence of the native inhabitants on their own land accompanied the wide-scale geological, hydrographic, and topographical study of the various provinces.

The ARDA legislation passed in the 1960s, along with land research and mapping projects, grew out of this exploitative ideology, continuing the development established by the white settlers. If we look at it from a postcolonial perspective, we see that CGIS was based on the same colonial practices—maintaining control and the dependency of the First Nations peoples on the colonial system—in order to develop capitalism and city planning. This program is based on a very limited and violent vision of state development. To this day, Canada continues practices of appropriating territories designated for the First Nations and the brutal exploitation of the environment for the extractive industries.[63] A computer system for processing data and producing digital maps could not, given the context of this history, be defined as a "neutral" tool, owing to the resources of its "database," as well as the methods of visualizing space inscribed within it. A critical engagement with the production of

tools for mapping Canadian societies and environments would require the active inclusion of diverse groups and individuals in the production of knowledge. This process would surely be difficult, considering the colonial history, which stripped many colonized subjects of agency, making them passive receivers of government support. In the ARDA program, action was taken to include the First Nations in the land inventories, yet this proved to be mainly focused on acquiring more information from them, not on improving their lot or decolonizing relations of power and knowledge.[64]

An Affective Analysis of the ARDA Program Maps

Let us move on the issue of representation. What conclusions can we draw using the approach suggested by Laura U. Marks with regard to the visual sphere CGIS offers? At the time of writing this article, the official Canada government web site provides several dozen maps developed in the framework of the ARDA project. Produced between 1961 and 1978, they are divided according to the original categories of the inventory program: the usefulness of the soil for agriculture, forestry, or recreation. According to Laura U. Marks, an affective analysis should involve three steps, identifying three separate processes: affective, perceptive, and conceptual. While the division into various steps is an artificial tactic, it is useful in turning our attention to the differences in the physical experience. Although we often apprehend all the qualities of a phenomenon at once, slowing our pace and breaking down analyses into three steps, focusing our attention on affect, unconscious processes, and physical reaction, allows us to depict the final concept of our analysis more accurately. Marks's methodological premises, stressing the abundance of unconscious physical experiences, are also based on actively opposing economic ideas that reduce[65]

people and their perceptions to organic processors of information.[66]

This analytical method is meant to return conclusions to the body, to slow down the process and encourage deeper reflection. This may, however, lead us to observe that a representation evokes no affective responses or closes off consciousness or the practice of naming to what transpires in the body. Despite the fact that, as Marks emphasizes, an affective analysis is conducted in the individual body, this does not make the arguments any less objective.[67]

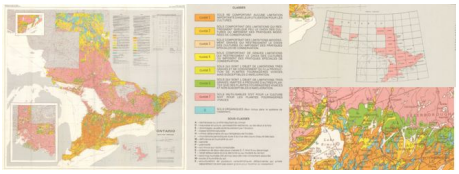

Fig. 2. Map of the Ontario region and close-ups of its parts. Government of Canada, Canada Land Inventory (CLI) 1:1,000,000, Soil Capability for Agriculture

Affect: a modification, a fold between thought and matter, an unrepresentable physical encounter. Maps made by the ARDA program have a geometrical, legible layout and a vivid color scheme, creating clear and aesthetically pleasing divisions between regions of a terrain classified by the inventory program. In the original version, these were found in offices of administrators, planners, and managers, in the form of large print-outs for studying seated, if the map was laid out on a desk, or standing, if it was hung on a wall. Now I can view them on my laptop. These compositions evoke a kind of physical satisfaction in me, a heightened attention characterized by a quickening of the pulse and raised blood pressure. My face wants to smile, as it does in moments of intense interest, but on the other hand, it wants to keep its expression of concentration or unease. The maps tend to have a great deal of detail and information, such as geographical names, locations, cities, railway lines, and provincial borders. The lines dividing the areas according to accepted soil classifications take on soft, rounded, sometimes quite complex geometrical forms. The eyes scan the map quickly, then more slowly, and because it is on a small laptop screen, I often have to click the mouse to zoom in on a detail and

then zoom out to see the whole (if the map was a print-out, zooming in and out would be a more dynamic process). My body reacts more with lively excitement than peaceful contemplation.

Percept: a *literary description of details that cannot be apprehended by the senses*. Focusing on a map of the Ontario region[68] representing soil classifications according to their use in agriculture, the map features an extensive legend, using a descriptive scientific language that ushers the viewer into the history of study and classification; additional shots of the mapped area compared to the larger scale of the whole country; two supplementary depictions with detailed information about the locations beyond the main scope of the map; a table with numerical values of the areas ascribed to the specific classes and sub-classes defined in the inventory program. The map has delicately drawn, gently curved lines of a cartographic grid. We search in vain, however, for land elevations or water depths—the mapped region is reduced to flat geometrical forms, drawn with lines and parsed with colors. The whole is surrounded by a frame that closes the mapped territory into a rectangular composition. The form of the Ontario map is dictated by European rules of cartography meant to ensure precision, legibility, and an overall image of the mapped territory. Its task is to "become" what is being mapped. This immediacy, rationality, and objectivity was meant to translate, in part, into the capacity to manage spaces that were very often remote from the centers of power, efficient travel across the seas and oceans, marking out trade routes or defining the exact borders of states. Western maps reinforce the view of the surface of the Earth as a whole that can be encompassed by a glance, a space systematized and structured by the bird's eye view of a geometrical, mathematical grid.[69]

Concept: it grows out of a critical comparison of affect and percept. Comparing my body's lively and enthusiastic response to the maps created using CGIS and my observations –

mathematically structured images presenting an alleged whole, offering information, but only that which is seen as valuable to a government sector – I conclude that I am dealing with a visually attractive representation that offers a highly restricted vision of the world geared toward the swift assimilation of the mapped reality and its control. I am delighted, yet overwhelmed by the representations which I know are not an adequate form of expressing what they are trying to grasp. I miss the opportunity to relate the map to my personal experience, the effort to explain the representations on the scale of the body, which would give me a deeper and more diverse sense of the complex phenomenon of soil (its properties are based on relations with the locally coexisting species of trees and plants, atmospheric qualities, and humans' social, agricultural, and technological actions). Knowing Canada's colonial history, I realize how many important and difficult stories should be taken into account and considered in a visual tale of this country's territory.

The forms produced using CGIS were designed according to the concept that a map is a territory, and thus a representation, not really existing independently of what it depicts; it is a subject of knowledge that can be monitored. According to Donna Haraway, the bird's eye view, or "God's perspective," reflects an essentially subjective path of knowledge that was embodied and ascribed a masculine position in the development of European cartography. In Western maps, "visual clarity in representation underpinned the scientific and technical authority of globes and

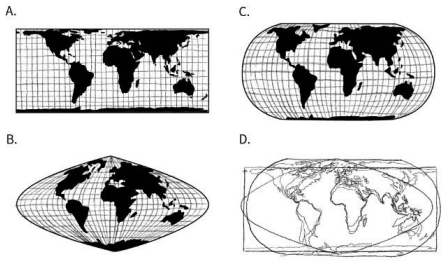

Fig. 3 A., B., C. Sketch Examples of cartographic projections popularly used in Western cartography, analogous to Mercator projections, rendering the earth's surface differently on a two-dimensional plane, while scale and perspective remain the same. D. Sketch of the differences occurring between the three projections. Based on fig. 4.4 w: Denis Wood, Rethinking the Power of Maps, Routledge, New York - London 2010, p. 93. Figure by the article author.

geographical maps themselves,"[70] thus constituting a separate characteristic of a cartographic fact. These maps held vital limitations in what they could show; for instance, in terms of favoring a reliable image of one fragment of the globe instead of another. One such example is cartographic projection developed by Gerard Merkator in 1569, which warped most countries and oceans past the equator, including those in the south of Africa, South America, India, and Oceania, demonstrating its Eurocentric focus. This projection is widely used at present in schools, offices, shops that sell decorative maps, and then in Google Maps and other Internet tools and apps that use maps, even though it misrepresents the sizes of land masses and bodies of water.

By exploring the intended recipient of this aesthetic and eye-pleasing form—administrators, planners, and designers working in the framework of ARDA—we can trace what power and knowledge relations upheld the colonial structures of exclusion. Agnieszka Jelewska describes the globe as "a tool for visualizing and designing how we imagine the Earth. One of the key consequences and roles that Western culture inscribed in this tool is to be a medium for colonizing practices, designing the Earth as the rightful property of those who arrive and discover."[71] Western cartography is also inseparably tied to the right to possess, imperialism, and colonialism, as well as its dramatic effects. We might even ask: "To what degree is the nation-state itself a perpetuation, rather than a supercession, of colonialism?"[72]

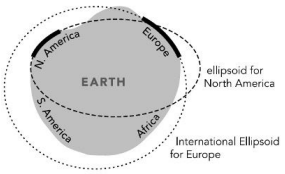

Fig. 4. Two proposals for mathematically describing the Earth's geoid: ellipsoids to capture North America and Europe, used in the 1950s by the U.S. armed forces, both impossible to use when attempting to represent Africa or South America. Illustration based on original available text by Irene Fischer, Is the Astrogeodetic Approach in Geodesy Obsolete?, "Surveying and Mapping," 1974, vol. 34, p. 128. Figure by the article author.

The clarity and precision of the representations produced by the CGIS system contains what Timothy Reiss has called

"aesthetic rationalism," a cultural and epistemological striving to achieve "depth with clarity, variety without confusion, interest with pleasure."[73] This pleasure might be enjoyed by many people engaging with rigorous aesthetic forms. A critique of CGIS maps does not entail a full rejection of their methods and the visualizations they use. In some solutions, representations of this sort could be helpful. As the creators of the Livingmaps Network project have shown, it is more important that the "contemporary mapmaking is a diverse practice with a multiplicity of meanings and uses."[74] We should seek solutions that go beyond the representations CGIS offers, because maps of its kind seldom pertain to everyday reality.

Since the mid 1990s, with the development of critical GIS and related streams of research, such as feminist, qualitative, or participatory GIS, scholars, activists, and educators have been working to redefine and in fact reprogram existing tools. One such collection of critical and transformative GIS practices and concepts is *Qualitative GIS: Mixed Methods Approach*; another is the four-part agenda of a critical approach to GIS described by Matthew W. Wilson, proposing a shift in how the tool is presented at schools and moving away from education on "neutral" technology as distinct from its social, political, and environmental impacts. The aim is to move past the narrow perception of reality as defined by the engineers and programmers of these tools, and also past what an uncritical scientific perspective offers.

A critical use of GIS can mean either reprogramming a tool or discarding it in the mapping process. The need to stress the value of diverse, non-digital, performative, and participatory mapping methods, as mentioned in the introduction, comes from a sense of the loss of essential qualities, resulting in the reproduction of existing power and knowledge relationships. A fine way of illustrating the critical use of GIS in practice is a collection of projects published in the framework of the aforementioned

Livingmaps Network. Its co-founders, Phil Cohen and Mike Duggan, have said: "the territory being mapped is itself partly made up of mappings, and these mappings increasingly put in question both the common sense principles of representation that are applied to them *and* the status of the knowledge claims which the maps or their makers themselves implicitly or explicitly make."[75] Maps, a territory, including organic and non-organic processes, human and non-human actors, data, electricity and atmosphere—all these components coexist in assemblies that constitute the functions of CGIS and its agency in social, environmental, and political spaces.

The New Materiality of the CGIS Tools

In visual terms, CGIS was not a massive leap forward from the previous analogue mapmaking using European cartographic techniques. It focused on transferring those techniques to the binary language of machines as precisely and smoothly as possible. Nonetheless, it offered capabilities quite unlike those afforded by earlier media, and created new material infrastructures that actively participated in these processes.

Approaching this from an "innovation" perspective, we see that the advent of CGIS programming presupposed the design and production of a computer system, user interface, and programming. Tomlinson commissioned the rendering of a cartographic scanner to produce handmade graphic drawings and record them in a binary format, to analyze and edit the scanned source map.[76] The program as a whole was developed on mainframe computers, composed of many separate units often resembling large, cumbersome wardrobes. The coupling between the human body and the computer can be traced back to the Cold War period, with the development of cybernetics and military flight simulators, joining features to test motor skills on various levels. This period saw a reformulation of human and machine perception, geared toward interaction and interface.[77]

The concept of a cybernetic interface presupposes it is a space of translation, an element that controls and facilitates communication.[78] As Orit Halpern demonstrates, the computer screen is not a "representation of an outside reality but a dynamic space to encourage the production of new associations, and further interactions—between people and between people and machines. The screen referred to further modes of interaction, not to anything outside the system *per se*; it was not a representational display of a world 'out there' but a translation zone aimed at inducing new modes of thought."[79]

By the same token, the "communicative objectivity" of the interface permits a fluid transition between the local and the global (the results of these concepts can be observed in both the CGIS interface and the present Google Maps).

In the early Human-Computer Interface (HCI) projects, the main aim was to depart from the textual script of the commands. At the same time, when mouse and keyboard prototypes or the first drawing programs (indispensable parts of today's computers) came out, experimental projects were introduced that involved the sensory capabilities of the human body to a much greater degree.[80] The direction ultimately chosen for developing the interface was meant to guarantee satisfaction with the click of a mouse, reducing the frustration of the subject, who was no longer a human, but a user, limiting both their motor and sensory involvement to the now-familiar minimum. The elements of CGIS technology like programming, computer code, and algorithmic functions, though not strictly physical, have a special kind of materiality. They are defined, for instance, through the make-up and characteristics of the computer

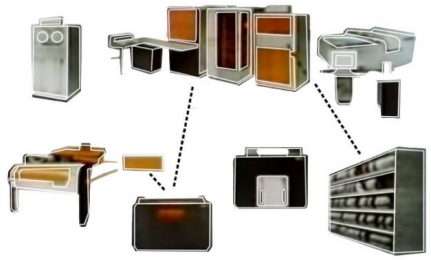

Fig. 5. Diagram illustrating CGIS hardware, part of the computerized infrastructure of a digital mapping program. Based on a frame from the film Data for Decision-Makers: Introduction to the Geo-Information System of the Canada Land Inventory, Ottawa 1967. Fig. by the article author.

language, which, when it comes to CGIS, approximates a natural language, and is more legible to people than a binary stream of numbers. In programming, which is, above all, operational, "the algorithms do the work." Here too, cybernetic premises come into play, by which descriptions of algorithmic processes become a space for designing new production techniques.[81] It would be a mistake to separate the code or algorithms from the "content," which concerns the social, environmental, and political, and affects the further operations of the programming. Both the programming and the databases are inextricably linked to the materiality of computer technologies—every act of processing information has physical effects in terms of the circuits, computer gear, and differences in voltage.[82] The code describes and facilitates uses, and the parts of its composition produce set premises; it also interacts with other platforms or programs, is distributed, creates phenomena occurring as a digital model or computational power.[83]

At present, GIS is based on infrastructures which did not exist at the point when the CGIS program was being developed. The transition from aerial photography to digital pictures taken by remote sensing systems and photogrammetry, as well as the development of the Internet, were driven by the post-Cold-War arms race. At present the densely wrought global network and monitoring apparatus evokes less powerful social responses than the iconic photograph *Blue Marble* of 1972 (the second most popular photograph taken from outer space) or the mass access to the Internet in the 1990s and the beginnings of e-culture. These phenomena are a reality that is hard to perceive, part of

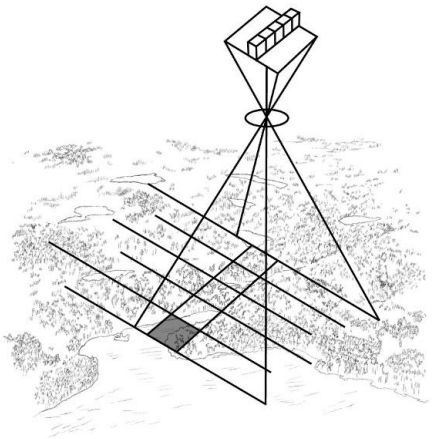

Fig. 6. Satellite sensor recording electromagnetic radiation of the Earth's surface. Fig. by the article author.

a nearly or totally inaccessible space, like undersea telecommunication wires or satellites circling above the equator in geostationary orbits. New terrestrial digital images code information based on recording electromagnetic and seismic waves and measurements of acceleration of gravity or sound waves, which are translated into formats people can understand. Satellite sensors record electromagnetic radiation through detectors, capturing and recording waves as pixel matrices. Every pixel represents a value corresponding to a recorded light intensity.[84] Cameras, sensors, radars, and scanners, like advanced programming languages (the closest to a human language), pass on information in a way people can understand, playing a vital role in formulating the message and shaping its use and understanding.

New Materialist theories presuppose that material is no mere backdrop for cultural and social development, not a passive element awaiting meaning to be assigned by human interests.[85] Data, computer equipment, programming, cables, electricity, and remote sensing technologies are not passive elements of a larger infrastructure. For example, data collected in CLI inventories and then processed in a computer system is not "raw material" subject to analysis and interpretation. As Mirka Koro-Ljungberg, Maggie MacLure, and Jasmine Ulmer comment, from a New Materialist perspective it is now impossible to "imagine the researcher positioned at arm's length from the data, exercising interpretive dominion over them, conferring meaning upon them, and marshaling them as evidence in a greater cause."[86] The data, like the other materials contributing to the creation and operations of CGIS, can cause difficulties in attempts to pin it down in space and time. Active and dynamic material transforms or appears in different ways in varying spaces, and this leads to interpretive imprecision. Non-human, living, or non-living materials involved in the production of CGIS digital maps are

dynamic, "vibrating" actors, interacting with other environmental, social, political, or technological factors.

Summary

A new technocultural device, the Canada Geographic Information System laid the groundwork for the development of later phenomena tied to the mapping of the reality around us. It had an immediate effect on decisions made on economic and state levels and on broader social and environmental phenomena. The widely known story of the creation and operation of the first geographic information system, CGIS, is limited and relatively formulaic, often reiterated in academic publications and textbooks and on commercial product web sites. The only chance to create "new paths" for operating future GIS systems is to dismantle and reorient these stories that are circulated, opening up the rigid boundaries of the scientific-commercial field and thus facilitating change. In this article I have used critical, feminist, and postcolonial methods to attempt to grasp and reconstruct the narrative around this tool, which has created a certain image of the world as ready to be colonized, classified, controlled, and extracted. Demonstrating the colonial practices and stories that actively shaped socioeconomic relations in Canadian society could be a first gesture of resistance against its social perpetuation and environmental violence.

1 James N. McCrorie, *ARDA: An Experiment in Development Planning*, Canadian Council on Rural Development, Special Study #2, Ottawa 1969, p. 24.

2 Mention of the initiation of work on this programming can be found, for instance, in the report: "The Canada Land Inventory: Objectives, Scope, and Organization," *Department of Regional Economic Expansion* 1970, no. 1, 2nd ed., p. 5.

3 See: James R. Beniger, *Control Revolution. Technological and Economic Origins of the Information Society*, Harvard University Press, Cambridge 1986.

4 We can also read about the characteristics of GIS in documents by Roger Tomlinson and in the following works: Matthew W. Wilson, *New Lines: Critical GIS and the Trouble of the Map,* University of Minnesota Press, Minneapolis 2017; Michael Curry, *Digital Places: Living with Geographic Information Technologies*, Routledge, London–New York 1998; Laura Kurgan, *Close Up at a Distance: Mapping, Technology, and Politics*, Zone Books, New York 2013; Paul A. Longley et al. *Geographical Information Systems and Science*, John Wiley & Sons, Chichester 2015.

5 Michael Curry, *Digital Places: Living with Geographic Information Technologies* , Routledge, London–New York 1998, p. XII.

6 The first version of the system only offered a visualization in the form of numerical descriptions of entries in charts. See: Michael Goodchild, "GIS and Cartography," in *International Encyclopedia of Human Geography*, Elsevier, Amsterdam 2009, p. 504.

7 Capturing and composing might seem to be the same as collecting and analysis , yet according to Emma Uprichard, methods of capturing and composing hold the potential of "interrupting and disrupting what they capture and compose" (Uprichard, p. 84). The object of the capturing process is an active material, not necessarily eager to surrender to the authority of classification and ordering systems. The etymology of the word "compose" has many sources: "put something together," "construct," "contain," "place." According to Uprichard, capturing and composing take us beyond individuality or complexity—these approaches have "the capacity of holding, folding and twisting—that is, compounding—partials and wholes simultaneously. Interdisciplinary research, in particular, often demand compound methods capable of capturing and composing the across contexts, in many ways and simultaneously" (p. 84). See: Emma Uprichard, "Capturing and composing: Doing the epistemic and the ontic together," in *Routledge Handbook of Interdisciplinary Research Methods*, ed. C. Lury et al., Routledge, London–New York 2018.

8 Mirka Koro-Ljungberg, Maggie MacLure, Jasmine Ulmer, "D...a...t...a..., Data++, Data, and Some Problematics," in *The SAGE Handbook of Qualitative Research Fifth Edition* , eds. N. K. Denzin, Y. S. Lincoln, SAGE Publications, California 2018, p. 828.

9 Emma Uprichard, "Capturing and composing...," p. 83.

10 Spartan Air Services, *Data for Decision-Makers: Introduction to the Geo-Information System of the Canada Land Inventory*, Ottawa 1967, www.youtube.com/watch?v=eAFG6aQTwPk (accessed: November 2, 2022).

11 Laura Kurgan, *Close Up at a Distance...*, p. 52.

12 Ibid., p. 52.

13 The scientific and specialist terminology knows the concept of "distributed GIS," defining systems whose components are not in any one physical location. I propose a different perspective, one that takes into account various stitched-together scattered programming, programming languages, and mobile apps, these conglomerates meeting all the characteristics of GIS (as defined by M. Curry).

14 Max Liboiron, "Firsting in Research," *Discard Studies* of January 18, 2021; https://discardstudies.com/2021/01/18/firsting-in-research/ (accessed: December 4, 2021).

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26 Robert J. C. Young, *Postcolonialism: An Historical Introduction*, John Wiley & Sons, New York 2016.

27 Ibid.

28 Ania Loomba, *Kolonializm / Postkolonializm*, Wydawnictwo Poznańskie, Poznań 2011, p. 34.

29 Banu Subramaniam, Angela Willey, "Introduction to Science Out of Feminist...," p. 6.

30 Ibid., p. 6.

31 Laura U. Marks, "Affective Analysis," in *Routledge Handbook of Interdisciplinary Research Methods*, ed. Celia Lury et al., Routledge, London–New York 2018, p. 153.

32 Ibid., p. 153.

33 See: Mirka Koro-Ljungberg, Maggie MacLure, Jasmine Ulmer, *D...a...t...a...*, *Data++...*, p. 815.

34 Roger F. Tomlinson, "The Impact of the Transition From Analogue to Digital Cartographic Representation," *The American Cartographer* 1988, vol. 15, no. 3, pp. 254–56.

35 Nicholas R. Chrisman, "Communities of Scholars: Places of Leverage in the History of Automated Cartography," *Cartography and Geographic Information Science* 2005, vol. 32, no. 4, p. 429.

36 Roger F. Tomlinson, *The Impact of the Transition...*, p. 252.

37 Ibid., p. 253.

38 This change was accompanied by a legislation name change to the *Agriculture and Rural Development Act* in 1966. See: Shannon S. Bower, *Tools for Rational Development...*, p. 45.

39 "The Canada Land Inventory: Objectives, Scope, and Organization," *Department of Regional Economic Expansion* 1970, no. 1, ed. 2, p. 2.

40 Zob. Shannon S. Bower, *Tools for Rational Development...*, p. 51.

41 "Northern Land Use," *Northern Land Use Information Series (NLUIS)*; https://sis.agr.gc.ca/cansis/publications/maps/nluis/250k/lu/index.html (accessed: January 4, 2023).

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43 *The Canada Land Inventory: Objectives, Scope...*, p. 4.

44 See: I. K. Crain, C. L. Macdonald, *From Land Inventory to Land Management...*, p. 43.

45 See: Shannon S. Bower, *Tools for Rational Development...*, p. 45.

46 Ibid., p. 49.

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48 See: Sarah Rotz, "'They took our beads, it was a fair trade, get over it': Settler colonial logics, racial hierarchies and material dominance," *Canadian Agriculture* 2017, no. 82, p. 159.

49 Ibid., p. 159.

50 CLI's task was less to acquire and gather new data than to arrange the enormous quantity of existing archives, which made it necessary to conduct new research and verify existing records. According to the creators of the program conducted from the mid nineteenth century onward, research on the quality of the country's land and natural resources yielded data with no uniform classification standards, which made them difficult to use in producing over 1,500 new maps. See: Roger F. Tomlinson, *The Impact of the Transition*, p. 252.

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54 Ibid., p. 56.

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57 Ibid., p. 54.

58 Ibid., p. 60.

59 Ibid., p. 173.

60 Ibid., p. 174.

61 Adam J. Barker, Toby Rollo, Emma Battell Lowman, *Settler colonialism*, p. 158.

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81 Ibid., p. 57.

82 See: Jussi Parikka, *A Geology of Media*, University Of Minnesota Press, Minneapolis 2015, p. 3.

83 Ibid., p. 4.

84 *Dane satelitarne dla administracji publicznej*, eds. Beata Hejmanowska, Piotr Wężyk, Polska Agencja Kosmiczna, Zabierzów 2020.

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