Epistemology of postmodern cartographic research and engineering of scientific knowledge building

Abstract :

The new technologies revolution has driven an epistemological rupture between modern and postmodern cartographic research. It has fertilized a new engineering of construction postmodern cartographic knowledge based on a fivefold epistemological foundation: naturalist (descriptive epistemology), normative (prescriptive epistemology), operational (experimental epistemology), critical (radical epistemology) and activist (epistemology activist). In practice, postmodern cartographic research is implemented from the paradigm of epistemological syncretism with four postures: constructivist (qualitative variable), post-positivist (quantitative variable), systemist (quantitative and qualitative variables) and interventionist (quantitative and/or qualitative variable). The epistemological positioning here consists in adopting one of these postures and implementing its specific methodological approach. The present study thus attempts to level the deficit of epistemological framing of postmodern cartographic research, which innovates with criticality, radicality and activist-commitment, while perpetuating axiological neutrality and methodological rigor. These innovations thus seal the break with the neutrality or knurling of university activism in the modern era. In other words, cartographic postmodernism opens a new era of academic activism for radical change.

Keywords: Epistemology, postmodern cartographic research, epistemological syncretism, academic activism, radical change.

Introduction

Cartography is the science of the maps study; the science of maps construction and exploitation (Papp-Váry, 1989 ; Perkins, 2003 ; Edney, 1996; Ferras et Hussy, 1994). The epistemology of cartographic research refers to the general theory of the search for scientific knowledge from cartography; the philosophy of scientific research of cartographic essence; the thought and art of constructing scientific knowledge from the maps study (Fairbairn, Gartner et Peterson, 2021 ; Azócar and Buchroithner, 2013a and b ; Cosgrove, 2007 ; Hallisey, 2005). The epistemology of cartographic research is quite distinct from the epistemology of cartography, which refers to the general theory of science whose object is the maps study. The latter, which revolves around the genesis and evolution of the thought of cartography, its currents, characteristics, trends, etc. is therefore disciplinary vocation. The first, on the other hand, is heuristic vocation and therefore analytical in the sense of Moellering, (2000 and 2001) and Tobler, (1976), integrates the field of science of research, innovation and creativity. This integration is based on foundations, paradigms and epistemic articulations that remain very little known among researchers. Ignorance and/or misunderstanding of these epistemic bases contribute to the production of cartographic knowledge at risk, in the service of political, doctrinal, and ideological interests... (Monmonier, 1993). It is also in favor of the trivialization of cartographic evidence and the falsification of cartographic evidence as an unanswerable argument inferred from visualization. The inferential link between empirical reality and its pictorial representation is biased and watered down, posing a serious problem of what Bryan Harley calls cartographic ethics (Ferras, 1997). This discredit is further promoted by the cartographic renewal which is being diffused by social networks and which do not always fit into the orthodoxy of cartography (Guichard, 2019; Peterson, 2003 et 1999).

This reality is the precursor of the present analysis, which poses the problem of the epistemological articulation of cartographic research. The objective here is to structurally and functionally characterize this joint. Structural characterization relates to the elucidation of its foundations and paradigms. Functional characterization refers to deciphering and reconstructing the actual process of constructing cartographic knowledge. The restitution of the study is structured in three parts. The first and second relate to the foundations and paradigms of the epistemology of cartographic research. The third articulation is a kind of engineering ecology of this construction.

1- Epistemological foundations of the postmodern cartographic research

1.1- Naturalistic foundation (description)

Cartographic knowledge comes from the transposition of empirical reality on a physical or digital medium, and from the methodical decryption of this representation. This knowledge is therefore constructed from empirical reality following a process of conceptualization of geographical essence (Béguin and Pumain, 2007). In other words, there is an empirical inking crystallizing the epistemology of cartography in the paradigm of naturalness according to which scientific knowledge emanates from

describable reality (Kuhn, 2008). Whether primary or produced, objective or subjective, societal or ecological, it must first be based on empirical facts, subject to their state of nature in the sense of the concrete or the non-artificial. This naturalness is a precursor to the descriptive or naturalistic epistemology of scientific research according to which the heuristic exploration of empirical reality is the basis for the construction of all scientific knowledge according to a very precise temporality (Jacquemain, 2014). Moreover, the naturalness of the knowledge produced is the first epistemological foundation of cartographic research; this knowledge thus describes the empirical reality and is therefore meant to be descriptive.

1.2- Normative foundation (prescriptive)

Cartographic knowledge is produced from a pictorial transposition of empirical reality into represented reality. This transposition depends on the projections that the researcher makes of the empirical reality to be transposed. It is based on conventional semiological systems of referencing, codification, symbolization, figuration, etc., establishing an inferential link between the field realities and their cartographic representation (Bertin, 1967). By illustration, a blue line or area on the map refers to a stream or stagnant water such as a lake, an orange line on the map refers to a road; a green surface on the map refers to vegetation… Cartography is thus governed by semiological standards inscribing it in the normative paradigm of the epistemology of scientific research. According to this paradigm, all knowledge must conform to a normative system in order to be scientific and conventional. This system also refers to the criteria of validity and veracity. This normativity is the foundation of the prescriptive epistemology of cartographic research, which is based on the criteria of scientificity of knowledge (Schroeder, 2015 ; Harre, 1984).

1.3- Operational foundation (experimental)

The construction of any scientific knowledge requires, according to Van Parijs (1982), a certain skill and performance. This is the reason for which it is legitimate to call an operational paradigm that hinges on practical experimentation. The experimentation has made it possible to identify several methodological obstacles of a technical or technological nature that have driven major reforms marked by epistemological ruptures in the sense of Kuhn (2008). It also forges an experimental skill that leads the cognitive construct (knowledge) to best approximate true knowledge corresponding to its temporality. This is the third epistemological foundation making cartographic knowledge an experimental knowledge, in addition to its naturalness and its normativity. This paradigm is the precursor of an experimental epistemology of cartographic research.

1.4- Critical foundation (radical)

The first three epistemological foundations above have been inherited from modern cartographic research. Postmodernism is characterized by the emergence and affirmation of a critical sense in cartographic research (Jiang, 2019 ; Azócar et Buchroithner, 2013c) based on two pillars. Firstly, there is the whistleblower pillar according to which cartographic research repositions itself as a powerful means of unveiling the feared excesses of governance that are hidden by politicians; a tool for revealing dysfunctions in the public space, discrimination, abuses and violations of rights and freedoms; a means of unveiling the cunning of rulers, and what is hidden from the general public; a mechanism for denouncing inequalities, territorial imbalances and dysfunctions, the oppression of minorities, the environment, etc. (Leroy, 2018). This pillar of critical cartography is not limited to the simple description of facts and phenomena. It is a tool for the description, analysis, explanation, understanding and interpretation of the mechanisms and processes which are at the base of them in their spatial variation and their temporal evolution, for the purpose of prediction. The second is the contributing pillar which is part of a perspective of regulation and prevention. The cartographic research of this pillar proposes solution scenarios to the problems under study that can be directly exploited by the public authorities (Taylor, 1994 ; Voskuil, 1950).

In general, critical cartography is based on a new state of mind characteristic of radical epistemology, which is based on taking a clear-cut position against a background of deciphering and denunciation, in relation to subjects by means of cartographic research (Rekacewicz, 2013). This foundation makes it a radical cartography. Postmodernism thus opens the era of critical cartography: a cartography of protest, a rebel cartography, or a map that says "no" as Zwer and Rekacewicz (2021) point out, or that says "yes". Ultimately, postmodern cartographic research has a critical foundation that goes beyond the simple description of what exists for the purposes of location and geographic location or displacement in modern times. This criticality further promoted by the Internet, and more specifically in the context of cybercartography according to Taylor (2009 and 2005), Reyes and Del Carmen (2005) and Peterson (2003 and 1999), has led to a progressive radicalization of this science which

benefits from the favors of new technologies, information and communication. It is therefore a precursor of the radical epistemology of postmodern cartographic research._It produced that Zwer and Rekacewicz (2021) and Rekacewicz (2013) call radical cartography.

1.5- Activist (activist) foundation

The criticality and radicality that constitute the very essence of postmodernist cartographic research implicitly carry the seeds of commitment and scientific activism in the researcher. Denunciation and protest, as well as the force of contribution and incitement to action or to act for change in research, are so many unstoppable indicators of a kind of scientific activism conveyed by cartographic research contemporary. Postmodernist thinking about cartographic research therefore has an activist underpinning that goes beyond the modernist passive shareholder essence of this research; an essence that made it a tool for planning, power, decision-making, etc., and which already transcended the traditional function of geographical location, information and communication. This activism must be understood, as Huish (2013a) points out, as a process of appropriating space and places of interaction with power structures. It is a mechanism for participatory engagement of researchers that is no longer passive in the traditional sense, nor active-soft in the modernist sense, but rather proactive and hyperactive for radical change. This new form of participatory engagement is one of the cardinal characteristics of Huish's (2013b) vision of academic activism in the university of the future.

This commitment to radical change is based on the construction of cartographic evidence and their interpretation. These constructs constitute so many unstoppable proofs of cartographic essence which are intended to be very accessible thanks to the Internet and easily understood by all; evidence with a strong capacity for persuasion and a strong capacity for rapid community mobilization (thanks to the Internet once again) to act in the collective interest (Desmette, Guillemette, 2010; Fontan, 2000) through disputes or claims. The above-mentioned activism therefore falls within the framework of scientific activism. In other words, there is an inferential link between postmodernist cartographic research, activism and scientific activism. The cartographic evidence that turns into cartographic proofs by means of decryption, analysis and interpretation, constitutes the very essence of this inferential link, the precursor of a true militant epistemology of postmodern cartographic research._It produced that Piceno and Deniau (2018) and De Biaggi (2006) call militant cartography.

Broadly speaking, militant epistemology is the general theory of the participatory and activist construction and implementation of scientific knowledge in the service of radical change; the thought of the weakening and deflagration of the devices, mechanisms and processes of alienation from societal and ecological sustainability, then of consolidation of the latter. It advocates a break with the shareholder passivity of modernist researchers and promotes the proactivity and even the hyperactivity of researchers in the participatory implementation of the results of their research by means of militant social mobilization. This new thought, qualified as academic activism (Fontan, 2000; Piotte, 2000; Gabrielle-Tremblay and Rochamm, 2013), thus breaks with post-research shareholder neutrality or knurling while perpetuating the axiological neutrality and methodological rigor of research. cartography as well as its conventionality (Lebel, 2009). Activist epistemology promotes the internalization of objectified activism in scientific research and the placing of scientific research at the service of rational activism in the collective interest.

Activist epistemology favors the emergence of what Meva'a Abomo, Kuna Maba Mmbuku, Maroundou (2021) call genuine militant research for radical change; research that goes beyond the simple production of scientific results. It recommends a set of militant initiatives carried out in a community interest by the researcher-activist and the social actors concerned by the object of research or sensitive to the issues underlying the societal or ecological problems of research. This behavior is a process with several gradual steps: awareness, awareness, motivation and impactful action. It is therefore a real militant communication that Led Freitag (1980) to rethink communication theories based on cartography. The militant issues here are persuasiveness, commitment and the impact of activist action (Piotte, 2000) in terms of militant implementation of the results of research in favor of radical change. It is therefore based on a certain state of mind and militant consciousness, continuous and constant in the researcher-activist, then the social actors; a state of mind that places activist research in overcoming the punctuality of initiatives of a simple research-action which are very often passive.

In a nutshell, postmodern cartographic knowledge has a quintuple épistemological foundation: naturalist, normative, operational, critical and activist. These foundations are the basis of the descriptive, prescriptive and experimental, radical and militant epistemologies of postmodern cartographic knowledge (Allard-Poesi and Perret, 2014; Piceno and Deniau**,** 2018; Leroy, 2018;

Rekacewicz, 2013; Azócar, 2012; Azócar and Buchroithner, 2013a, b, c and d) that guide any researcher consciously or unconsciously in the cartographical postmodernism.

2- Paradigms and epistemological positioning in postmodern cartographic research

2.1- The Paradigm of Cartographic Syncretism

Scientific research is done from epistemological paradigms which are the logical frameworks of the construction of scientific knowledge (Avenier, Gavard-Perret, 2012). Postmodern cartographic research takes place within the syncretism paradigm which is a logical framework of construction of knowledge based on the triangulation of the structural invariants of three atypical paradigms: constructivism, interpretivism and post-positivism; it can be contextualize as cartographic syncretism. In principle, any process of scientific knowledge production in cartography is based on the interactions between the object and the subject, which later results in representations of reality. Any cartographic research process is therefore inherently constructivist; because subject-object interaction and the representativeness of reality are cardinal attributes of constructivism (Piaget, 1970). Similarly, any cartographic representation of reality or empirical reality, as well as any subsequent extraction of scientific knowledge, are products of the logic of representation and interpretation of this reality by the researcher. This process is also interpretivist in essence. The interpretation and representativeness of empirical reality for the purposes of systematized cartographic representation are cardinal attributes of interpretivism (Everært-Desmedt, 1990). The articulation of these first two paradigms gives rise to interpretative constructivism.

Furthermore, quantification in general is embodied in the process of producing cartographic knowledge. This is perceptible from the ratios of metric proportionality between the real dimensions of an object and those of its projections on the map. The scale of a map is thus an indicator of the effort of metric standardization of these reports. In general, the sense of proportional measurement or metric proportionality intervenes directly or indirectly in any process of mental projection, cognitive representation and cartographic transposition of a fact or phenomenon. Conversely, it intervenes intuitively and/or mechanically in any reading, analysis and interpretation of a map. Because, these exercises are always accompanied by a projection of the real object by the reader from its pictorial representation for the purposes of intelligibility and understanding. The engineering of cartographic knowledge therefore has a strong quantitative anchoring, a precursor to predictive projections of reality. However, measurability and predictability are cardinal invariants of post-positivism (Béguin and Pumain, 2007) which, therefore, are embodied in the process of developing cartographic knowledge. Ultimately, any exercise in drawing up or analyzing maps takes place within the paradigm of cartographic syncretism, which is the articulation of constructivism, interpretivism and post-positivism.

2.2- An epistemological positioning around three postures

Cartographic syncretism, which is the common basis of all cartographic research, is underpinned by three variants that can be assimilated to epistemological postures. Firstly, it is *the constructivist syncretism posture* where the objects exploited are qualitative: vegetation, soils, land use, socio-cultural areas, etc. (Figure 1). This exploitation is based on the constructivist operating mode or the qualitative approach without any involvement of the researcher in the production of the facts studied. This posture, however, integrates the sense of measure intuitively incorporated into the various mental projections.

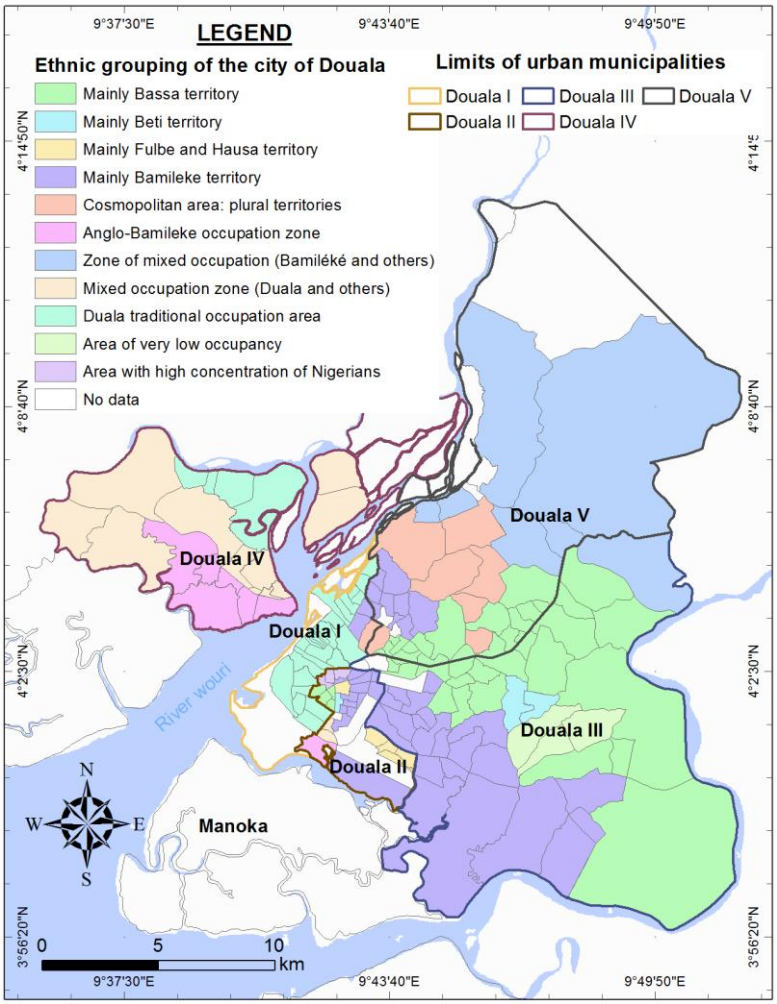


Figure 1: Illustration of a map relating to a qualitative object of study *(Regroupings by ethnic groups in the city of Douala, Cameroon),* falling within cartographic syncretism with a constructivist posture

Data source: Douala Urban Community. ©Foka Nkwenti Christopher, 2022.

The second posture is *the post-positivist syncretism* where the objects exploited are quantitative: densities, prevalences, rainfall, temperatures, etc. (Figure 2). The operating mode is post-positivist or quantitative. The objects to be measured and mapped, at best, to be mapped, according to Rimbert S. (1995), are first of all the object of projection and constructivist representation without any involvement of the researcher in the production of the facts also studied.

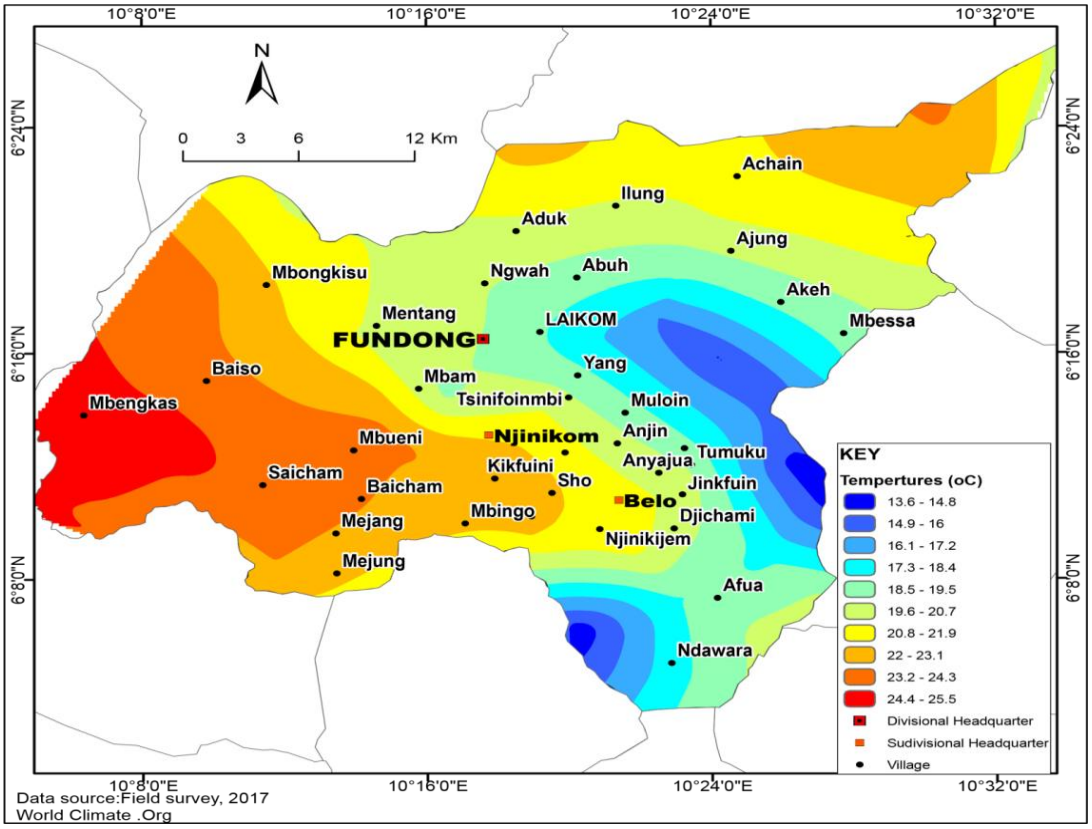


Figure 2: Illustration of a map relating to a quantitative object of study *(Temperatures in the highlands of Kom, North-West Region, Cameroon*), falling within cartographic syncretism with a neo-positivist posture

Data source: Word climate.org and field survey.
© Zetem Chiambah, Mbifung Lambi, Fogwe (2021).

The third posture is *the systemist syncretism* where the two types (qualitative and quantitative) of cartographic research objects are simultaneously treated. The operating mode here is synthetic-multimodal (Aktouf, 1992), which is operationalized from a mixed research method without any involvement of the researcher in the production of the facts studied as previously. Legends in this case, for example, have two articulations, one for each type of data. The fourth posture is *interventionist syncretism* where the exploited objects are measurable, non-measurable or all of two. The approach can be consecutively constructivist (qualitativist), neopositivist (quantitativist), synthetic-multimodal (mixed), with the particularity of the intervention or involvement of the researcher in the production of the facts studied. Epistemological positioning therefore consists in the choosing of any one of these fourth epistemological postures.

3- Knowledge engineering and cartographic knowledge

3.1- From mental construction to graphic transposition of imaged and imagined order

Map is a representation of part of the earth's surface using conventional signs. Its approaches of definition have as a common denominator, which is the concept of "*representation*" according to two of its three meanings. The first relates to the representation as a psycho-cognitive modeling of the perception of an objective or subjective reality by a subject; this is, in principle, the mental representation of the object (Moellering, 2000). The second refers to the representation as a graphic transposition of the mental modeling of an object on a documentary and archival support of physical or digital orders, using a conventional and universal graphic semiological system (Bord, 2000; Moellering, 2000 et 2001). This is, in fact, the graphic representation of the object which is only possible after the psycho-cognitive modeling of the said object. The mental representation therefore precedes the graphic representation. The third meaning relates to the *representation as a substitute or substituent*. This is the physical representation.

In practice, each of the first two meanings, namely *mental representation* and *graphic representation*, falls into two orders: pictorial and imagined. *Pictorial mental representation* is the psycho-cognitive construction of a faithful physical image of reality from a mental projection of a physical object. It is therefore the imaged or virtualized reality that results, as Jacob (1992) points out, from an intellectual, artistic and even artisanal movement giving shape and contours, putting into space knowledge, rumors, hearsay... on the world. *The pictorial mental representation* is not the map itself, but a projection, a faithful psycho-mental reproduction of reality; it is the graphic transposition in all authenticity of this mental representation on a physical or digital support from the cartographic semiological system which, in fact, is the map. Any graphic transposition is therefore the pictorial graphic representation based on a precise semiological system. The diversity of semiological systems implies a diversity of pictorial graphic representations; and any graphic representation is therefore not necessarily cartographic. It is evident when the reference graphic semiological system is cartographic.

According to the second imagined order, the representation is an imagination that comes from the creativity, the inventiveness, and the innovation of the subject from the object. It is not reality, nor its faithful and exact physical image in the sense of pictorial representation; it is a perception, a synthetic conception of some reality; what the researcher says about it; a product of the decryption, analysis and interpretation of the object in its postures as fixed as dynamic in space and time by the subject. It is, as Brunet, Ferras, Théry (1993) underlined, the form that an idea, a phenomenon, an object, a space takes in the human intellect. It is therefore the imagined mental representation; a construct of psycho-cognitive activity which is part of going beyond the simple reproduction of the physical image, faithful and exact of reality, or quite simply, going beyond the *mental representation imaged* by the power of the observation, decryption, analysis and interpretation. In other words, when the pictorial mental representation is descriptive, *the imagined mental representation* is analytical and interpretative, in addition to being also descriptive.

The graphic transposition of any imagined mental representation of a reality produces an *imagined graphic representation* thanks to a given semiological system. In total, the cartographic representation is a calligraphic transcription on any support of the graphic representation according to two orders: imaged (figure 3) and imagined (figures 4 and 5), from the graphic semiological reference of the cartographic type.

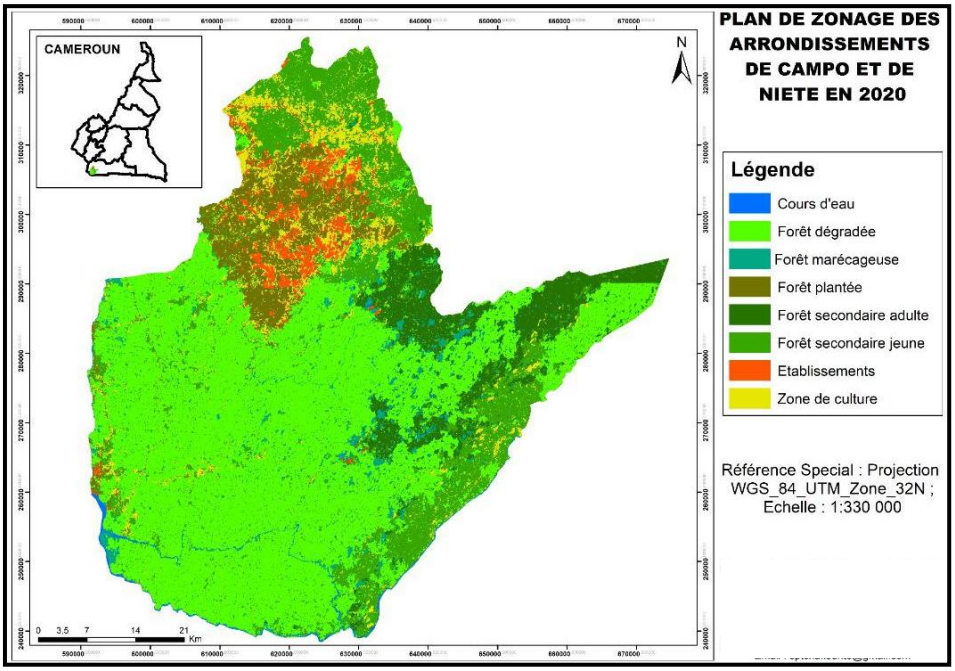


Figure 3: Illustration of a map drawn up according to the constructivist posture from pictorial graphic representations *(Types of forests in the districts of Campo and Niété in southern Cameroon in 2020)*

Data source : Image Landsat 7 du 25-01-2020. © Tchakounté Stéphane, 2020.

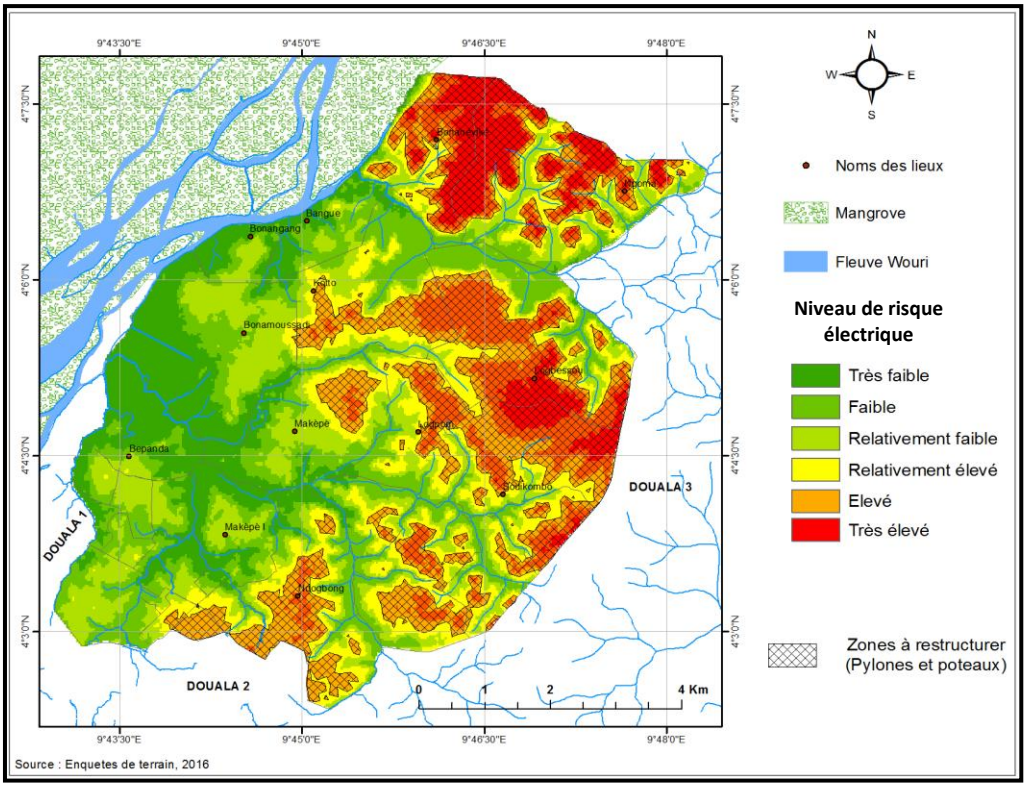


Figure 4: Illustration of a map developed according to the post-positivist posture from imagined graphic representations *(Variation of electrical risk in the 5th district of Douala in 2016):*

Data source: *Tchangou Wépandjoué A. (2017).*

3.2- Implicit and explicit cartography

The construction engineering of cartographic knowledge takes place according to two levels of scale: the elaboration of the maps and their exploitation. During these technical operations, the researcher engages in a highly intellectual activity, makes strategic choices on what to retain, represent and transpose within a multitude of data. He carries out an intense psycho-cognitive activity in all coherence of reasoning. It is marked by peaks of psycho-cognitive resonance during which the higher intellect, hyper-activated, fertilizes ideas, reflections, extracts or psycho-cognitive aggregates of an explanatory (causal or characterizing) or interpretative (significant or predictive). The psycho-cognitive treatment of these primitive aggregates consists in bringing out their apparent and deep meanings, their morphologies and contours if necessary. It leads to the production of two types of materials. The first is formless material; that is to say, the refined primitive aggregate which remains in an ideal or imagined lightning state without form or morphological contours in the mind of the seeker. This product is therefore an imagined archetypal material. The second product is a material with morphological shape and contours in the mind of the researcher as a projection of a real physical object. This treatment of the primitive aggregate produces an *archetypal imaged material* (*in the form of an image*). All in all, the elaboration and the hermeneutic deciphering of the maps is based on the engineering of archetypal materials as much imagined as imaged.

Generally speaking, a psycho-cognitive aggregate is not knowledge; but, an archetypal material exploited in the construction of scientific knowledge. These materials *are epistemological explicit or implicit* (Anquetil, 2018), of a cartographic nature in the engineering of the production of cartographic knowledge. On the one hand, the materials revealed are the cartographic explicit. Their eligibility among the thousands released in the decryption, analysis or interpretation project depends on their relevance, their interest, their meaning, their consistency with the body of knowledge to be built and the inherent issues. The reconstitution of the corpus of knowledge is done from the structural aggregation and the functional arrangement of epistemological explicits or archetypal materials worthy of being revealed. These are the aggregates that are timely, most meaningful, rational, persuasive, and most appropriate to the logic of reasoning consistently and rationally.

On the other hand, materials that are unrevealed or revealed in other terms in the form of presupposition, innuendo, illocutionary trope are epistemological implicits in the sense of Kerbrat-Orecchioni (1986), in the sciences of language. These are, in principle, cartographic implicits in the engineering of the construction of cartographic knowledge and skills. They also have a utilitarian function in this reconstruction. These "unsaid" or these "said in other words" depend on the understanding and interpretation of what must be said by a researcher by example, always in the sciences of language, metaphors, so-called playful intentionalities, idiomatic expressions, interjections, etc. (Anquetil, 2018). Cartographic implicits therefore play an important role, as archetypal materials with proven utility, in one way or another. They are exploited in the shadows to give meaning to reasoning, build a demonstration, deconstruct and/or frame the fields of perceptions and interpretations, shape the explanation, orient and channel understanding, gain acceptance and forge validation of the knowledge built from a coherent and rational linking of cartographic explanations resulting from the same analysis exercise. As much, there emerges a multitude of types of implicit cartographic whose modeling reports three cardinal matrices.

- The matrix of archetypal materials

In the construction engineering of cartographic knowledge, cartographic explicits are archetypal materials, imaged or imagined, which are objectified, carrying meaning, logic, strategic meaning in relation to the project. The cartographic implicits are archetypal materials imaged or imagined at risk, little or not significant, incoherent and inappropriate in the state compared to the project. *A matrix of archetypal materials* of knowledge construction engineering and cartographic knowledge can be drawn up. It is made up of cartographic explicits of imaged order and imagined order, then of cartographic implicits of imaged order and also imagined order.

Map implicits can specifically be modeled into two categories each having two classes. These are, on the one hand, *the marginal cartographic implicits* which are purely and simply rejected, ignored and excluded from the process with regard to their inadequacy, their contradiction, their opposition,… to the logic and the coherence of the reasoning. This category includes two classes. The first-class marginal epistemological implicits that refer to those who have a very strong capacity for nuisance and who are generally hidden by several researches; embarrassing archetypal materials sometimes having a strong detonating capacity and compromising the veracity, then the validity of knowledge resulting from research. Their non-revelation therefore has a proven utilitarian function because it contributes to the consolidation of the logical meaning of the reasoning and the internal coherence of the knowledge under construction. Their revelation, on the other hand, very often undermines the patterns of coherence of the logical framework of knowledge. It weakens or practically breaks the intelligibility of reasoning to the point of generating refutations of the veracity and validity of knowledge. The unveiling, later, of certain epistemological implicits deliberately omitted or wrongly dismissed to force the result, can lead to the decline of several researches, and the scientific discredit of several researchers and laboratories. *The first-class cartographical implicits* therefore carry the seeds of the falsification of many studies. These implicits are often used to produce cartographic representations for ideological and extremist purposes; a kind of Design of cruelty according to Angeloni (2019). *Second-class marginal cartographical implicits* refer to those whose disclosure cannot discredit or deconstruct the reasoning, nor constitute a potential threat to the veracity and validity of the knowledge elaborated. These are materials deliberately discarded in all rational logic in order to build a coherent reasoning.

The second category refers to *non-marginal cartographic implicits* which are archetypal materials not revealed as they are and indirectly exploited (Anquetil, 2018). This category includes non-marginal cartographical implicits of the first class which concern the materials not transcribed as they are, but from their translation into other words, their insinuation, certain aspects of their deep meaning… These reconsiderations are in favor of the consolidation of the internal coherence of the body of knowledge and its external functional harmonization. *Second-class non-marginal cartographic implicits* concern materials exploited from the angle of "illocutionary trope" which is, according to Anquetil (2018), Kerbrat-Orecchioni (1986), a figure of speech characterized by the inversion of the original meaning , a change of meaning, the communication of the opposite of the content of the material, a diversion of meaning, an erroneous and negative meaning… They therefore constitute the breeding ground par excellence for putting cartographic knowledge at the service of doctrinal, ideological and political currents. The cartographic implicit is, ultimately, a bearer of risks, dangers and multiple issues. Each class of cartographic implicit, both marginal and non-marginal, can fall under the imaged or imagined order. The result is a profile of eight types of cartographic implicits.

- The matrix of mental representations

Mental representations are the constructions by structural and functional aggregation of archetypal materials resulting from psycho-cognitive resonance. Eligibility and the actual selection of materials are rigorous and demanding. All the mental representations thus fleshed out are not always revealed in cartographic research. The result is *explicit or revealed representations* built from explicit cartographic ones, *and implicit or unrevealed representations* forged from the aggregation of implicit cartographic ones. Each type of representation can be imaged or imagined. A new matrix of standard forms of mental representations in cartographic research can thus be reconstituted. The first and second forms are *the explicit mental representations of imaged order and imagined order* respectively. The third and fourth forms are *the implicit mental representations of imaged order and imagined order respectively*. Moreover, each imaged or imagined order of implicit mental representations has two categories: marginal and non-marginal. Each category is structured into two classes: harmful and non-harmful. The result is a profile of eight types of mental representations implicit in cartographic research.

- The matrix of graphic representations

The materialization or calligraphy of each standard form of mental representation on a given medium produces a specific form of graphic representation. This results in another matrix of standard shapes. These are *explicit graphic representations of imaged order and imagined order* on the one hand, then *implicit graphic representations of imaged order and imagined order* on the other hand. The existence of eight types of implicit mental representations of cartographic essence therefore leads to the existence of eight types of implicit graphic representations of cartographic essence. Implicit graphic representations are of two orders: imaged and imagined. Each order has two categories: marginal and non-marginal, and each category has two classes: harmful and non-harmful. A profile of eight types of graphic representations implicit in cartographic research can thus be established.

The three matrices (archetypal materials, mental representation, graphic representation) thus modeled constitute the matrix triptych of psycho-cognitive tools for constructing knowledge and cartographic knowledge.

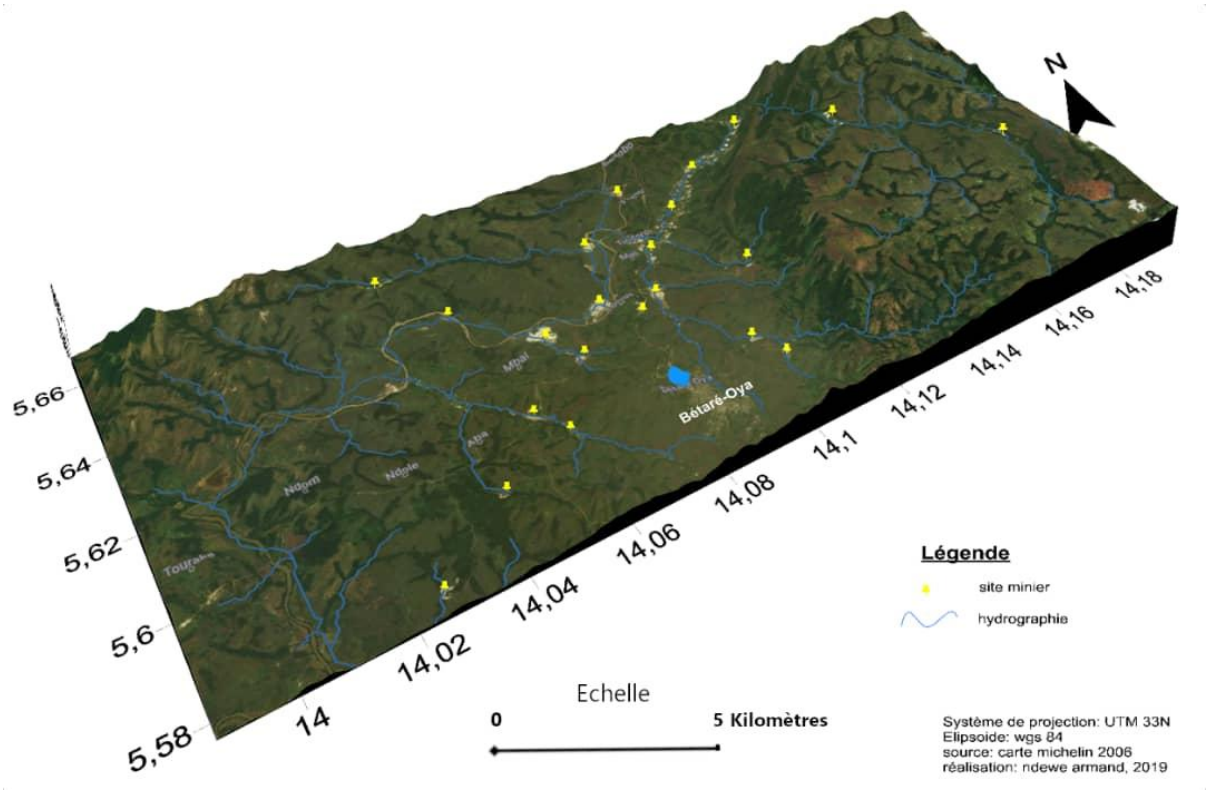
3.3- The scale levels of construction of cartographic knowledge

There are two scale levels for constructing cartographic knowledge. Map making is the first level. It is the process of transcription, then of structured and coherent, intelligible and objectified arrangement of cartographic representations. This coherence and this objectivity are forged by the non-transcription of certain so-called implicit graphic representations. This subtraction or selective representation contributes to the consolidation of the inferential link between the real object and its mapped image. Any objectified arrangement (the map) is therefore, as Farinelli (1989) quoted by Fourez (2004) points out, an instrument made up of appearances that become reality in the minds of the cartographer and the reader; an arrangement reflecting a perception of the territory among many others (Ferras, 1993). As Fourez (2004) points out, the most important thing is its coherence and its relevance according to the project and the associated issues. As much as this arrangement requires knowledge to be carried out, it is itself a producer of knowledge from the staging of structures that are not always visible in the landscape but only viewable. It is about *graphic knowledge of cartographic essence* whose merit is, in the sense of Brunet (1990), to have succeeded in the bet of making visible or showing the political, social, cultural landscapes... of a space, that no one can physically see because of their immateriality.

The second level of cartographic knowledge construction scale, namely, the use of maps, is a psycho-cognitive activity relating to the reading, analysis and interpretation of existing cartographic layouts (Bord, 1984). The raw material explored during this activity is therefore the map, and not the empirical, real or primary data. This hermeneutical decryption follows a double process. There is firstly the inverse process of the elaboration of the maps: visual disarrangement of the whole, isolation of the individual cartographic representations, imagination of the basic graphic representations, analogical deduction of the mental representations which were its precursors as well as of the presumed archetypes of starting knowledge. The result is a profile of analog archetypes of knowledge. The second process is the reconstitution of analogical knowledge: categorization of archetypes into analogical explicits and implicits, selection and intelligible arrangement of deduced analogical explicits. This reconstruction is also based on a semiological reference system allowing interpretation.

The use of aerial photos and satellite images and the development of associated maps are based on constructivist and/or post-positivist postures of cartographic syncretism. They are articulated around the same matrix triptych of psycho-cognitive tools for constructing knowledge and cartographic knowledge. Only, to the mental representations are added the representations of artificial intelligence.

The archetypal materials here are digital. These artificial materials and representations are preconfigured in semiology software and digital media. Their arrangement produces cartographic illustrations in 2D and 3D (Figure 5). Whatever the case, this approach highlights questions that are not directly perceptible, both geographical in the sense of Ferras and Hussy (1994), and sociological, economic, anthropological, political, etc. It produces fundamentally imagined knowledge that is a matter of hermeneutics, and therefore of the interpretativeness, creativity and inventiveness of the researcher (Fourez, 2004). This decryption *produces hermeneutic knowledge of cartographic essence*; what Fourez (2004) qualifies as representative and analogical scientific knowledge.



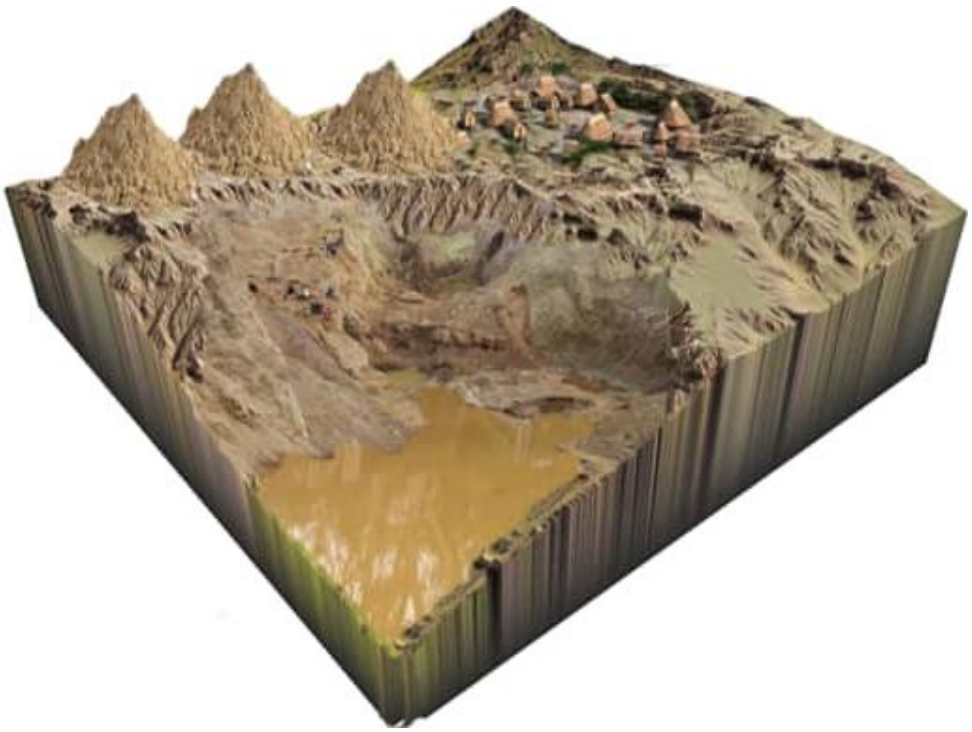


Figure 5: (*Digital terrain models of a field of mining sites in Bétaré-Oya in East Cameroon)* developed according to the constructivist posture from graphic representations of artificial intelligence

Data source: Open Street Map 2021, INC, 1998. © Ndewe Armand, 2021.

Conclusion

The revolution of new technologies has prompted a decisive turning point, even an epistemological break in the sense of Kuhn (2008) between modern and postmodern cartographic research. It has produced a new construction engineering of postmodern cartographic knowledge. This engineering is a heuristic process that has a fivefold epistemological foundation. These are the naturalist (descriptive epistemology), normative (prescriptive epistemology), operational (experimental epistemology), critical (radical epistemology) and activist (militant epistemology) foundations. In practice, postmodern cartographic research is a kind of hybrid, composite or mixed epistemological paradigm. This is cartographic syncretism operationalized from four postures: constructivist, post-positivist, systemist and interventionist. Any epistemological positioning in cartographic research therefore consists in adopting one of these postures of syncretism and implementing its specific operating mode. In other words, each epistemological posture determines the methodological choices.

Furthermore, cartographic postmodernism has produced a new generation of illustrations favorable to better visualization (in 3D) and a more critical analysis of empirical realities; because, these new forms of pictorial and imagined representations have the merit of arousing the immersion of the user in the heart of the empirical facts and phenomena visualized, of bringing him to feel virtually their tangible and imaginary realities, to identify with them and to feel their direct or induced effects. These new shapes, like Figure 5 above, allow better analysis and visual appreciation. They are also in favor of a fine critic of the facts and phenomena visualized which may relate to the organization of the occupation and the risky enhancement of the functional space, social inequalities, territorial dysfunctions, the degradation of environment, etc.

The major issue here is the construction of cartographic evidence that legitimizes the coherence and relevance of reasoning; consolidates his persuasiveness and leads to knowledge. Through this evidence, cartographic knowledge leads to making choices and establishes itself as a decision-making tool. Cartographic evidence, also called cartographic reason in the sense of Perret (2019), is ultimately the soul of graphic evidence, which conveys the persuasion of cartographic reasoning. It constitutes itself in this cartographic proof, which becomes an unstoppable link in this reasoning to convince. It is therefore endowed with a great power of persuasion and carries the

awareness seeds, sensitization, motivation and incitement to individual or collective action. It can therefore serve as a trigger for protest, denunciation and claim movements on the one hand; or popular movements of defence, encouragement and protection of certain good initiatives on the other hand. These attributes sufficiently demonstrate that it conveys a powerful power of mobilization, radicalization and militant activism. This reflection thus attempts to structure and characterize the epistemological articulations of this cartographic postmodernism.

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