

The GEOSTAT Hypotheses:

In search of a high resolution foundation for Geostatistics in Europe; an interactive response to operational user needs in a time of transition.

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Abstract

This paper is intended to set the scene for a planned Statistics Sweden ESS initiative to build a high resolution harmonized foundation for Geostatistics in Europe.

The methods adopted for the GEOSTAT¹ project is pragmatic in Rorty's sense. This means that hypotheses presented are practical proposals to be judged by their utility. The Paper presents seven hypotheses or proposals that the project will try to discuss. 1) The "Spaceship Earth" hypothesis argues that the earth should no longer be regarded as self-regulative and deterministic. It depends on deliberate human control to attain sustainability. 2) The "paradigm" hypothesis argues that the paradigm concept is a valuable tool to describe, analyze and discuss this predicament in holistic terms. This is necessary for discussing the emerging ecological "world view" and serve as a foundation for global agenda to handle current and future threats and opportunities. 3) The "Cybernetic approach" hypothesis argues that sustainable world cannot be built only developed through a controlled, step by step piecemeal "engineering" process based on rationality and qualified information. 4) The "GIIS" (Global Integrated Information System) hypothesis argues that a infrastructure of spatial data suitable for cybernetic type control should be developed for this purpose. This could in Europe be developed from the data themes proposed in the annexes to the INSPIRE directive. 5) The "STDI" (Spatial & Temporal Data Infrastructure) hypothesis argues that a true spatial (and temporal) data infrastructure must Provide web services to present integrated spatial and temporal models of man environmental systems in professional and academic context. 6) The extended "ESS" hypothesis argues further that the need for a GIIS will require the NSI's to provide a neutral foundation of microdata that may be aggregated separately for "accountant" and "engineering" needs. 7) The "ESSgrids" hypothesis proposes for "engineering" purposes a harmonized hierarchical grid based foundation for any kind of statistics required for an operational GIIS.

Keywords: [Geostatistics, Small area statistics, Inspire]

1. Introduction

The INSPIRE² directive is the European response to the acknowledged need for a shared global infrastructure of spatial data (as described in the INSPIRE annexes). The directive implies the building of a spatial data infrastructure (SDI as developed by the JRC led INSPIRE project). This infrastructure is needed to support the harmonized production, distribution and use of this system of spatial information to serve the design, implementation and evaluation of policies, programs plans and

¹ For details on the GEOSTAT proposal please see (EFGS 2008) *The Geostat Project Proposal (Version 20081103)*

² See (European Parliament and Council 2007) *Directive 2007/.../EC of the European Parliament and of the Council of establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) (Joint text approved by the Conciliation Committee)*

projects for sustainable development. The European Forum for Geostatistics (EFGS) is concerned about the INSPIRE projects current interpretation of the term “spatial information”. It has tried to bring attention to the role of statistics in the INSPIRE project by stating that there can be no real infrastructure of spatial data or spatial data infrastructure without a true integration of geography and statistics³. Further the EFGS has realized that the NSI’s of Europe is primarily concerned with the production and dissemination of statistics aggregated to administrative areas for ex post public management (“accountant”) purposes. The ESS and the NSIS have on the other hand no neutral system of small statistical areas to satisfy ex ante (operational “engineering”) needs. This requires a unified system of small area statistics that may be cross analysed with any kind of socioeconomic and/or environmental data required for the ecosystem approach to sustainable development. The EFGS proposes for this purpose the establishment of an “ESSgrid “system of geostatistics, a grid based hierarchy of discrete grids dedicated to this end.

This document should thus be regarded as a background for the overriding purpose of the EFGS, and a Statistics Sweden’s ESS Committee initiative concerning four issues:

1. The establishment of an European Forum For Geostatistics (EFGS)
To establish a network to serve as a Professional Reference Group (PRG) and link between Eurostat and the NSI’s. This PRG will be concerned with questions related to the integration of geography (INSPIRE) and statistics (GEOSTAT) as the first step towards a Global Integrated Information System(see the GIIS and the STDI hypotheses)
2. The initiation of the GEOSTAT “ESSgrid” project
To provide a high resolution harmonised foundation for statistics liberated from administrative areas that may be integrated with any kind of statistics into a trans-professional GIIS to serve as a foundation for projects according to the requirements of a true “ecosystem approach”. On all scales from global to local⁴.
3. The initiation of a joint EFGS and EUROSTAT led infrastructure project
To contribute to an expanded SDI (see the STDI hypothesis) and build an European Geoportal for the dissemination of distributed geostatistics, later to be integrated with the INSPIRE hierarchy of portals presently under construction.
4. The launching of a case study (URBIS)
To demonstrate and test the utility of a STDI based GIIS to serve as a shared foundation for policies programs plans and projects for Sustainable Urban development.

2. Seven hypotheses or proposals

2.1. “Spaceship Earth”

1) A human being is a living system that excels in the interactive processing of matter, energy and information. Every moment awake we receive enormous amounts of information through our senses that is used to construct, maintain and reconstruct a model (reference) of the outside world in our minds and bodies. This integrated system of knowledge is used as a foundation for every step we take and every word

³ See (Backer 2007) *The “European Forum for GeoStatistics”; and the next step towards an infrastructure of spatial data for sustainable development in Europe.*

⁴ The project aims to present the results of the 2010-11 European Census on km grids.

we utter. The effect of our actions are keenly observed and fed back to our minds in a never-ending cycle of “observing”, “acting”, “observing”, “acting”... This endless series of iterations that come as natural to us as breathing in and breathing out and has two effects. It changes the world around us and it changes us.

2) Many of our best minds have spent considerable amounts of time in order to understand and communicate what we mean by the term “modernism”. For many this idea is closely connected with the discovery of the power that stems from the conscious combination of two ideas; the idea of building shared information systems (science) and the idea of developing ever more complex well orchestrated collective actions implemented with purpose and rationality (practice).

3) The first truly modernistic period that we generally called “the industrial age” has been a tremendous success for those national states that understood its potential in time. As an example we may consider how the manufacturing output in Sweden increased fivefold between 1830 and 1871, it registered a tenfold increase in only 30 years up to 1900. From there followed a twenty fourfold increase between 1900 and 1950 when forty percent of the industrial output was exported. Once the Swedish economy had achieved a take-off it was sustained. Over the whole century 1870-1970, the national per capita income rose over this long period 2, 1 per cent per year!⁵. On a global scale we are seeing a series of very serious problems that reminds us about what should be obvious to all; exponential curves like these cannot last.

4) The late architect and engineer, Buckminster Fuller, has argued that we are suddenly awakening to the insight that we are passengers and crew onboard “Spaceship earth” a closed system⁶ with limited resources.⁷ just as a bird that, at the same moment that it has spent its eggs resources and is developed enough to fend for itself, breaks open the shell now must forage on its own legs to discover the next phase of its evolutionary process.” *We find ourselves now, just about to step out from the pieces of our just one-second-ago broken eggshell⁸. Our innocent, trial and error sustaining nutrient is exhausted. We are faced with an entirely new relationship to the universe. We are going to have to spread our wings of intellect and fly or perish: that is we must dare immediately to fly by the generalized principles governing the universe and not by the ground rules of yesterday’s superstitious and erroneously conditioned reflexes⁹. And as we try competent thinking we immediately begin to reemploy our innate drive for comprehensive understanding.”¹⁰*

5) Now this is a remarkable and far reaching observation that goes far beyond the simple ideas of growth that we have inherited from the industrial age. We are forced to admit that the world is no longer self-regulating or deterministic, neither in terms of the whole nor in terms of its major parts. This means that we, whether we agree or not, are forced to take responsibility for the future of the earth as a habitat for

⁵ See Hall, Peter. 1998. *Cities in Civilisation; Culture, Innovation, and Urban Order*. London: Weidenfeld & Nicholson

⁶ “A feedback system, which is sometimes called a “closed” system, is influenced by its own behaviour. A feedback system has a closed loop structure that bring the results from past actions back to control future action.” (Forrester 1968) *Principles of Systems; Text and Workbook* (1-5)

⁷ For an early awareness of this threat see (Meadows et. Al. 1972) *The limits to growth: A report for the club of Rome’s project on the predicament of mankind*

⁸ This reminds us of the story from the bible that describes Adam and Eve’s expulsion from paradise. (See the Bible Genesis 3:24.

⁹ This reminds us of our enlightenment heritage, see “Aufklärung ist der Ausweg des Menschen aus seiner selbstverschuldeten Unmündigkeit. Sapere aude! Habe Mut, Dich Deines eigenen Verstandes zu bedienen! ist also der Wahlspruch der Aufklärung.” (Kant 1784): *Was heißt Aufklärung?*

¹⁰ See (Buckminster Fuller 1971) *Operating Manual for Spaceship Earth*

mankind. We are forced to take action for our own welfare and survival, on a global scale. This is not only a metaphysical-, but essentially a very pragmatic challenge.

2.2. “Paradigm”

1) Before 1960 the word paradigm was generally used the word was specific to grammar: The 1900 *Merriam-Webster* dictionary defines its technical use only in the context of grammar or, in rhetoric, as a term for an illustrative parable or fable. In linguistics, Ferdinand de Saussure used *paradigm* to refer to a class of elements with similarities. However, after the debate around Thomas Kuhn’s influential book on the topic¹¹, the word has referred to thought pattern in any scientific discipline or other epistemological context. The Merriam-Webster Online dictionary defines this usage as “a philosophical and theoretical framework of a scientific school or discipline within which theories, laws, and generalizations and the experiments performed in support of them are formulated; broadly: a philosophical or theoretical framework of any kind”. The strength of this concept is that it does not recognize the traditional gap between “science and practice” or “sciences and practices”.

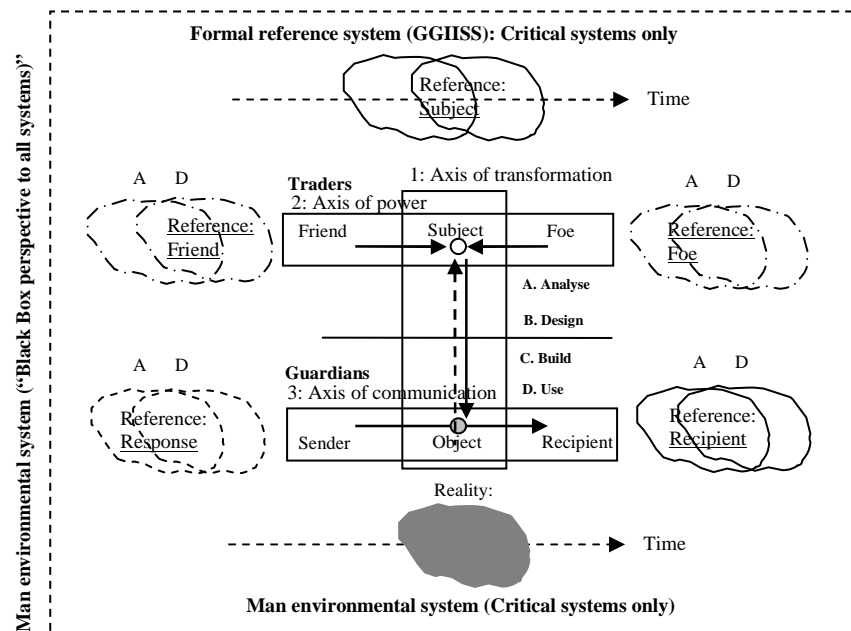


Figure 1: Greimas actanten model modified by the author

2) The paradigm idea must may also be thought of as an integrated “grand narrative” or overriding project (in Lyotard: s sense¹²) never fully described in one single source. We all compile our comprehensive understanding of the current Global situation from a series of disparate world wide sources. For collective purposes they should not be limited to the descriptive or explanatory natural sciences, but embrace any useful information from general sources to the arts and humanities as well.

3) To analyse and bring structure to all relevant information we need an efficient and merited method. One such method could be the *Actanten model* proposed by the Russian semeiotic Propp and the French philosopher Greimas in the 1970’ies¹³. For text analysis. This method may very well be used in combination with e.g. the structuralist methods devised by the anthropologist Levi-Strauss¹⁴.. Greimas proposed

¹¹ See (Kuhn 1970) *The Structure of Scientific Revolutions*

¹² See (Lyotard 1979) *The Post-modern Condition: A Report on Knowledge*

¹³ See (Greimas 1987) *Actants, Actors, and Figures*

¹⁴ See (Levi-Strauss 1963) *Structural Anthropology*

the diagram above to analyse the different active and passive roles played by passive and active players as related to their actions (projects, contributions to development).

4) This scheme describes the structure of all kinds of “narrative” fragments to be organized around three intersecting axes. Applied to an effort to describe a paradigm for sustainable development, actions (projects) may be developed in the dialectical relationship between 1) the axis of communication where the hierarchy of public authorities (Guardians¹⁵) is the “sender” providing “sustainable development”(ends) to the recipient (Mankind). The difference between “Guardian” and “Trades” roles are essential; the role of the “Market” (the axis of power) is to provide the dynamics for the production of variety, and that of the “Guardians” to provide the control. The focus however for global development projects are the vertical (the subject- object axis of transformation (desire)) where the “Subject” is using the services of “Traders” to serve the “Guardian” sustainability project.

5) Figure 1 presents an extended version of the original model. The “clouds” behind the actors responds to the authors idea that every action is founded on an information system of reference that is more or less “taken for granted” and only partly shared by the other actors participating in the narrative.. I prefer to refer to this system of knowledge as the different actor’s interpretation of the shared “culture” or “grand narrative”. This implies that a paradigm should be seen (and modelled) as a complex whole that includes both knowledge and action.

2.3. “Cybernetic”

1) One of the key challenges involved in the current paradigm shift is probably to get beyond the traditional production of “open systems” as tools for human use, and find new ways to control and develop the global MES as a “closed system”.

2) Raymond Kurtzweil¹⁶ notes in the foreword of his “The age of intelligent machines”, the importance of regarding tools as extensions of our capabilities. Breakthroughs in the development of our tools have brought about important paradigm shifts. The first industrial revolution was triggered by the invention, and development of, machines that multiplied our physical abilities, and current second industrial revolution promises to provide us with leverage for our mental capabilities.

3) This development promises the possibility to develop intelligent man environmental “machines” that, as human beings, control their interactions with the world outside with the help of a multidimensional (GIIS) qualified model containing all necessary “critical” information about its context. In its interaction with the world of which it is part, it may seek its objectives through an iterative process analogous to the human “observe / read”, “act /write”. As for the crucial system of information used for reference, we have no way to know (or care) whether our model gives a “true” or complete representation of really what is out there. We only require that it consists of the most critical information and that it “works” as an effective foundation for our actions. In this sense we live to the pragmatic principle that “*the proof of the apple is in the eating*”¹⁷

¹⁵ I have used the concepts “Guardians” and “Traders” according to Jane Jacobs (Jacobs 1994) *Systems of Survival; A Dialogue on the moral foundations of Commerce and Politics*

¹⁶ FSee (Kurtzweil 1990) *The Age of Intelligent Machines*

¹⁷ See “*We cannot regard truth as a goal of inquiry. The purpose of inquiry is to achieve agreement among human beings about what to do, to bring about consensus on the ends to be achieved and means to be used to achieve those ends. Inquiry that does not achieve coordination of behaviour is not inquiry but simple wordplay. To argue for a certain theory about the microstructure of material bodies, or about the proper balance of powers between branches of government, is to argue about what we should do: how we should use the tools at our disposal in order to make technological, or political progress. So for pragmatists there is no sharp break between*

4) Cybernetics¹⁸ is the science of control of closed systems. It studies the flow of information within self-regulating systems, and the way in which that information is used as means of control. Control in this sense is not related to coercion, or forceful manipulation. It is a notion of internal arrangement in the interest of desired performance. The central challenge to any project to develop “closed systems” according to cybernetic principles must necessarily provide a strategy to bridge the traditional gap between theory and practice into a new interdependent relationship.

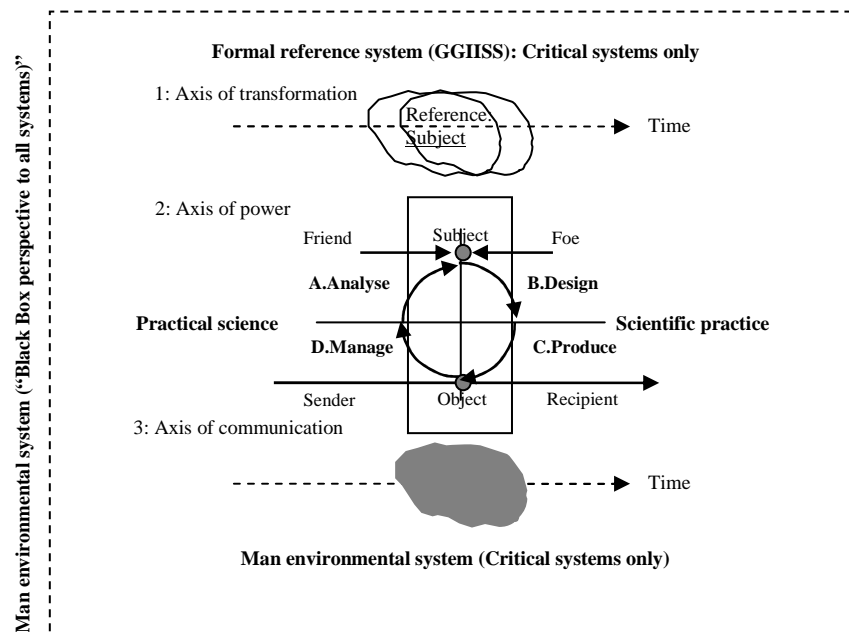


Figure 2: Cybernetic process where information systems (systems of reference) are used to control complex man-environmental systems.

5) Please consider the linear ABCD (Analysis (ex ante knowledge)), B (Design), C (Produce), D (Manage (ex post knowledge)) process in figure 1 and the circular process 1 B1 C1 D1 A2 B2 C2 D2 A3 B3.etc.. The key to the cybernetic idea is that (A&D) processes contribute to the development of our (virtual world) reference system (e. g. GISS) , and the (B&C) processes contribute to the development of our (real world) structures and processes. The relationship between design and practice (B1&C1, B2&C2, etc.) is seldom a problem in this context. However, the relationship between (D1&A2, D2&A3, etc.) creates a series of difficult problems for the generation- and use- of practical information systems

6) The problem of scope of the systems to be controlled, modified and modelled with critical information may be contemplated from two important perspectives. The first is related to the idea that the global MES may be regarded as a hierarchy of systems, subsystems and suprasystems that stretch over all scales from local to global. This perspective is essential for a discussion of the scale problem that is very important for providing useful information for action on different levels of public authority. The other is related to the contents of the information considered. This is a very serious matter due to reductionistic thinking patterns we have inherited from the industrial

*natural science and social science, nor between social science and politics, nor between politics, philosophy and literature. All areas of culture are parts of the same endeavour to make life better*¹⁷. There is no deep split between theory and practice, because on a pragmatist view all so-called “theory” which is not wordplay is always already practice” From the introduction to (Rorty 1999) *Philosophy and Social Hope*

¹⁸ The word Cybernetics stems from the Greek (*kybernētēs*, steersman, governor, pilot, or rudder — the same root as government). (See Wikipedia). The seminal work in applied systems thought appeared in 1948 in the form of Norbert Wiener’s “Cybernetics”(Wiener 1948) *Cybernetics*

area. This trap may be illustrated with the widely used DPSIR (Driving forces, Pressure, States, Impact and Response) method. The DPSIR is a variant of the (D&A) process which is widely used in discussions related to environmental monitoring and reporting. This scheme is generally depicted as one circular process to describe mans impact on the natural environment. It does not include a similar DPSIR circle contemplating the natural environments impact on society.. So used this scheme cannot be said to represent a true ecological approach because it considers only one half of the MES, and t thereby accepts the “kit of parts” division between society and the environment. The main consequence of the “closed system hypothesis” is that we are forced to see the “natural environment” and “the artificial environment” as inseparable and interdependent whole.

7) The principal characteristic of controlling information with the cybernetic approach is called feedback. Basically all cybernetics approaches are based on the efficient interaction between two aspects analogous to the A&D processes in the general description above. There is a considerable difference between information needs for “accountant” and “engineering” use. Engineering type information describes “real world” systems from an information perspective that focuses on what is required to build maintain and develop man environmental systems. Accounting systems on the other hand produces “virtual” models the world where structures and processes are considered in economic terms as “assets”, “costs” and “liabilities” aggregated to relatively stable administrative areas. The difference may be illustrated with the information needs to develop an urban system from an economic perspective, as compared to handling the same problem from a pragmatic or technical perspective.

8) There is no doubt about the legitimation for both of these “complementary” systems of information for other sides of the cybernetic “feedback” cycle:

1. Production of Virtual models of our MES¹⁹ (Integration of A & D processes)
 - a. Analysis & Management (ex ante & ex post information for engineering purposes)
 - b. Analysis & Management (ex ante & ex knowledge for accountant purposes)
2. Production of the Real world MES (Integration of B & C processes)
 - a. Design & Production (practical actions from an engineering perspective)
 - b. Design & Production (practical actions from an “accountant” perspective)

9) Traditional statistical systems are of the “accountant” type. We are well served in this respect. For practical “engineering” purposes on the other hand, we obviously lack the suitable data and data infrastructures to meet the challenge of taking control over critical systems on a global or even European level.

10) A pragmatic approach does not recognize a fundamental difference between the methods to be used for theory (science) and practice (action). Both processes may be written in the form ABCD.

1. A normal “practical science” project using a standard deductive method would be based on previous (empirical) feedback (D0). It would produce a hypothesis that he/she hopes will better serve users needs than previous theories (A1). To test this hypothesis, an experiment is designed (B1) and implemented (as a thought experiment or in reality)(C2) Evaluation results (critique) (D1) are provided as fed back to (A2) and subsequent iterations.

¹⁹ Man Environmental Systems (MES). This term stresses the interdependence of , or dialectical relationship between the environment and society.

2. A normal “scientific practice” using a standard inductive method will found its process on an analysis of previous (real world) feedback information (D0). It would produce a concept that he/she hopes will better serve users needs than previous practices (A1). To test this concept, a solution is designed(B1) and implemented (as a thought experiment or in reality) (C1) The evaluation results (critique) (D1) are provided as fed back to (A2) and subsequent iterations.

11) The virtual world knowledge (D&A: scientific practice management feedback = practical science knowledge) and the real world production ((B&C: practical science experiment = scientific practice production) are but two sides of the same coin.²⁰ Their integration will require a more scientific practice and a more practical science.²¹ And a close cooperation between scientists and professionals.

2.4 “GIIS”

1) If we accept the cybernetic approach to the development of complex MES then we are confronted with the need to re-design, re-build and maintain a qualified system of reference based on the data themes listed in the INSPIRE annexes²². The following issues must be addressed.

1. The data themes in the annexes are not structured and do not reflect any organisational concept that reflects the informational requirements for an ecological approach.
2. The data themes are not selected or structured according to the expressed need to provide public authorities with information to approach development problems.

2) The “Spaceship Earth” hypothesis points to a radical change in our relationship with world that we have brought upon ourselves by our own free will. If it is true, also in general terms, that “*if you cannot describe it, you cannot manage it*,”²³ then we who are engaged in the provision of qualified information for a sustainable development of the world, have to rethink our roles, strategies and priorities

3) The earth is complex far beyond our ability to describe it in all its detail. If we are to believe the pragmatist argument that truth cannot be the goal of scientific inquiry, then the best thing to do is to present schemes that have proved useful in practice and suggest these as a hypothesis to be tested by their utility for practical use in a “closed system” with cybernetic control²⁴. On this foundation it seems safe to suggest that (1) the Earth may be described as an integrated man- environmental system (of systems). And (2) that this hierarchy of systems may be described in terms of a dialectic between human systems (societies) and the environment. For practical reasons the Environment may be further broken down into the natural environment (NE) and the built environment (BE) and human systems into sociocultural systems (SS) and economic systems (ES) respectively. To manage man-environmental systems we need identical integrated spatial and temporal models to describe both the environmental (NE + BE) and human societies (SS+ES). This is to be compared with the use of the same type of (ABCD) models for iterative development as proposed above.

²⁰ Augustin would say about this that “Nulla est homini causa philosophandi, nisi ut beatus sit” (Book 19, Chapter 1 of City of God.) There is no reason for man for doing science than with a view to happiness (utility)

²¹ As an illustration of what is meant here please see (Brown 2008) *Plan B 3.0; mobilizing to save civilization*. This book does is not limited to a one sided analysis but also provides proposals for solutions (the plan B).

²² Strangely enough this strangely disregarded crucial collection of “data themes” has no proper structure and is generally referred to as “the annexes”.

²³ See (Hammer and Champy 1993) *Reengineering the Corporation: A Manifesto for Business Revolution*

²⁴ This is another aspect of the idea of “critical information”.

4) Let us consider the use of this model on a practical science or a scientific practice project . According to a pragmatic ecological approach its immediate utility will have to be judged against its effect on the systems as a whole²⁵ . An interactive engineering or reporting approach to a Sociocultural problem (like the overpopulation) would focus on the (SS) project, but under consideration of its effect on the whole (SS+ES+BE+NE). An interactive engineering or reporting approach to an Economic problem (like the current crisis of the capitalistic system or resource constraints) would focus on the (ES) project, but under consideration of its effect on the whole (SS+ES+BE+NE). Similarly an interactive engineering or reporting approach to a problem related to the Built environment (like unsustainable urban environments) focus on the (BE) project, but under consideration of its effect on the whole (SS+ES+BE+NE). Or an interactive engineering or reporting approach to a problem related to the Natural environment (like global warming) would focus on the (NE) project, but under consideration of its effect on the whole (SS+ES+BE+NE). Given an integrated system of spatial information (GIIS) of the type envisioned here, one integrated system of reference may suffice for judging the impact of a project upon the whole and at the same time serve as a seed for specialized sector oriented policies programs plans and projects.

2.5. “STDI”

1) If we assume that the inspire directive and its annexes should serve as the foundation for a proper STDI, then we have to solve a series of inadequacies with regards to the SDI required:

1. The STDI must respond to public authority information needs
2. The STDI must respond to the need for standard semantic object models for critical information.
3. The STDI must respond to a genuine integration of geography and statistics
4. The STDI must respond to the problem of scale
5. The STDI must provide access to general references (legal acts, standards, scientific reports, public authority policy documents etc.)

2) The informational revolution has brought us the ability to build feedback systems on a grand scale. Integrated information systems are the key to any development scheme according to cybernetic principles. This crude draft for a STDI (extended SDI) structure is intended for both “engineering” and “accountant” purposes.

1. Narratives (Background information (grand narratives) that describes a problem in its context.).
 - a. Description of the reference system upon which the project is founded
 - b. Description of the project or projects designed to develop targeted systems
2. Object (concept) based semantic models. Objects may be described as systems of systems that form hierarchical structural and functional entities).
 - a. Spatial “object” models (“Kits of parts” structural models)
 - b. Spatial and temporal “object” models (“Interacting whole” dynamic models)

²⁵ This requires for instance, in the case of an urban development project, that changes should be designed and judged against its effect upon the rest of the urban manmade environment, the natural environment, society’s socio cultural networks and clusters, as well as economic system (the holistic reference).

3. Spatial and Temporal Model²⁶
 - a. Models 1: Statistics. (Statistics and systems of statistics)
 - i. Non spatial object at a given point in time (static)
 - ii. Non spatial objects over a time period (dynamic)
 - b. Models 2: Cartographics²⁷ (Maps and systems of maps)
Objects described with focus on spatial representations (Points, pixels (2d), voxels (3d))
 - i. Spatial object at a given point in time (static)
 - ii. Spatial objects over a time period (dynamic)
4. Reference information. (Documents and collections of related documents)
 - a. Reference information 2 (What to do): Information from the humanities (efforts to discuss values etc. in relation to actions)
 - b. Reference information 1 (How to do): Information from science (efforts to describe and explain systems)

3) The structure suggested and built by the INSPIRE project does not take into account the essential question of scales or scale ranges. This is however essential from both “accountant” and “engineering” perspectives, due to the fact that the information needed for the management of global scale project cannot be provided by a simple scaling up of the same information that is needed on a local scale. For an illustration of this please consider this hierarchy of scales required for spatial development below.

1. Global system (planet earth as an integrated whole)
2. Scale interval “Hemisphere” (modelled in 10 000 km windows)
The Scale of global subsystems, continents, large international regions (e.g. USA, EU, Russia etc.) Object sizes (1 km (min) – 100km (max))
3. Scale interval “National state” (modelled in 1 000 km windows)
Large national states (Poland, Germany, France, Spain etc.). EU macro regions (e. g. Baltic region) Object sizes (100m (min) – 10km (max))
4. Scale interval “National region” (modelled in 1 00 km windows)
Small national states (Belgium, Luxembourg), national regions, very large urban regions. Object sizes (10m (min) – 1km (max))
5. Scale interval “Urban district” (modelled in 10 km windows)
Medium sized towns, municipalities / communes, Urban districts Object sizes (1m (min) – 100 m (max))
6. Scale interval “Local” (modelled in 1 km windows)
Urban blocks and urban neighbourhood. Object sizes (10 cm (min) – 10 m (max))
7. Scale interval “Urban block” (modelled in 100 m windows)
Urban blocks and house clusters Object sizes (1 cm (min) – 1 m (max))
8. Scale interval “House” (Modelled in 10m windows)
House here is interpreted as the scale of a building section with an entrance and stairwell Object sizes (1mm (min) – 10cm (max))

2.6. “Extended ESS”

1) Our new role as guardians of the sustainability of MES will require improved “accountant” and “engineering” capabilities on a global scale. The statistical systems

²⁶ Perhaps the key obstacle to the building of a true integrated spatial and temporal data infrastructure are in addition to the problems in statistics related to differences between “accountant” and the “engineering” perspectives, are problems related to the integration of geography and statistics that has become evident in the INSPIRE process.

²⁷ In the meaning “the production of maps, including construction of projections, design, compilation, drafting, and reproduction.”

of the world will have to play an important role in future efforts to contribute to the building of an efficient GIS systems from the INSPIRE annexes.

2) The majority of our NSI's produce official statistics mainly from a traditional "accountant" (generally "ex post") perspective aggregated by default to administrative areas. It has been argued that the traditional "accountant" type statistics may serve as a foundation also for "engineering" type purposes. This is probably a mistake.

3) The pragmatic problems that we need to solve require information and methods to handle these problems from an ecosystem "engineering" perspective. These require high resolution data (ideally point data) that when necessary may be aggregated for analysis to a neutral system of regular tessellations (e.g. grids).

4) The Tandem projects²⁸ have shown that statistics aggregated to "fixed" administrative areas for "accountant" purposes make them unsuited for further spatial analysis. By aggregating statistics to a system of administrative areas (irregular tessellations), we have de facto performed an "accountant" type analysis where valuable spatial patterns are lost and cannot be recreated even with sophisticated disaggregation methods.

5) It seem that a "state of the art" statistical system should refrain from using "accountant" type statistics for "engineering" purposes and vice versa;

1. To satisfy both "accountant" and "engineering" needs we need a statistical system built on a neutral foundation of micro data that is "*liberated from administrative areas*"
2. To satisfy "accountant" type user needs we have a very sophisticated system of statistics available that is aggregated to several types of standard administrative areas (irregular tessellations).
3. To satisfy "engineering" type user needs we need a parallel system of spatial statistics that is aggregated for spatial analysis to a hierarchy of regular tessellations..

2.7. "ESSgrid"

1) According to the "extended" ESS we have argued in favour of building and maintaining two separate types of statistical aggregations. For engineering purposes, we need a single system of regular tessellations that may serve as a foundation for all the different types of statistics required for analysis and cross-analysis in a GIS environment.

2) For this purpose, the EFGS has through its GEOSTAT initiative proposed the construction of "ESSgrid" a full coverage, hierarchical grid based standard system for aggregating any kind of statistics so that these may be compared and cross-analysed for use on any level of public authority from global to local. The system follows the principles laid down in the Eurogrids recommendation.²⁹

3) The GEOSTAT project has started with a preliminary pilot study that tries to plot the European gross population on km grids. The GEOSTAT project approaches the problem from a combined "top – down" (disaggregation) and a "bottom – up"

²⁸ The TANDEM projects, that serve as a foundation for the GEOSTAT initiative, have tried to show that "accountant" type administrative areas (irregular tessellations) are (if at all-)not very suitable for "engineering" type analysis. See here the two Tandem projects. Tandem 1 (Backer, Tammilehto-Luode, and Guiblin 2001) *Tandem GIS: A (Feasibility) study towards a common geographical base for statistics across the European Union (The first iteration)* and (Tammilehto-Luode, Backer, and Guiblin 2003) *Tandem II: Towards a Common geographical Base for Statistics across Europe: The final Report: Appenices*

²⁹ See (JRC 2005) *European Reference Grids workshop: Proceedings and Recommendations* and there (Backer 2005) *In search of an Infrastructure for Spatial Analysis*

(aggregation) approach to be integrated in a hybrid (integrated) version where the aggregated data serve to calibrate the disaggregation processes.

4) To demonstrate this with real data, according to the pragmatic principle that “the proof of the apple is in the eating”, the GEOSTAT project endeavours to present the results of the 20010-11 European census on km grids and demonstrate its utility on one or more relevant case studies (See figure 3) .

5) The ESSgrid system will be based on the Eurogrid system for statistical grids. This recommendation is however limited to use in Europe due to the standard projection selected³⁰.for our hemisphere. This recommendation will however have to be substituted by or complemented with a global solution as the United States national Grid system³¹ .

3. Conclusions

1) If the global system is no longer self-regulated and deterministic the global community of public authorities must take charge. The first overriding task is to improve the sustainability of the global man environmental system. This is a very complex, but pragmatic task that will require methods that relies on a close cooperation between a more practical science and a more scientific practice..

2) Sustainability cannot be built it must be developed. This document proposes an iterative cybernetic feedback approach that accumulates knowledge and improves the performance of MES over time. (See the “cybernetic” hypothesis)

3) The key to this scheme is the accumulation of a viable GIIS harmonized system of critical information that serves both “accountant” and “engineering” purposes. This system must according to the ecosystem approach be designed to model MES from a holistic perspective.

4) The INSPIRE directive provides the first step in this direction. This document proposes to bring this process one step further by; a) focusing on the need to develop the data themes listed in the annexes into a prototype for a useful information system of reference that may serve practical development efforts (see the GIIS hypothesis) and b) develop the spatial data infrastructure (SDI) proposed by the INSPIRE project further to solve critical problems related to scale and scope (see the STDI hypothesis).

5) One major obstacles to this strategy is that the “accountant” type official statistic provided by the ESS and the NSI’s to describe critical systems are poorly adaptable to use in the “engineering” type task ahead. For this purpose we need a parallel system of spatial statistics that is liberated from administrative areas. (See the “extended ESS” hypothesis)

6) The EFGS and the Geostat project proposes a hierarchy of discrete grids built according to the EUROGRID recommendation. As a first step it will try to present the results of the 2010-11 European censuses on km grids. (For the current state of the project see figure 3. and GEOSTAT project proposal³².)

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³⁰ The Eurogrid recommendation proposes to adopt ETRS() Lambert Azimutal Equal Area coordinate reference system for spatial analysis and display.

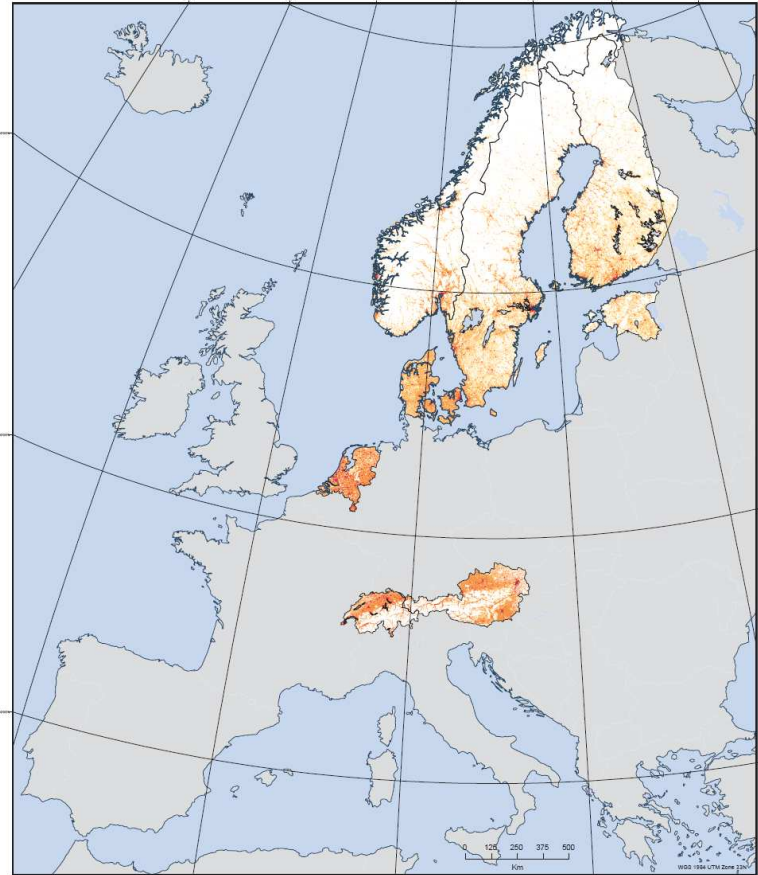
³¹ See (Standards Working Group 2001) *United States National Grid*

³² See (EFGS 2008) *The Geostat Project Proposal (Version 20081103)*

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Population by 1 square km grids

A grid map based on population register data. Population data are geocoded with coordinates on buildings, addresses or real estates.



	Austria	Denmark	Estonia	Finland	The Netherlands	Norway	Sweden	Switzerland
Date	1.1.2006	1.1.2006	31.3.2006	31.12.2004	1.1.2006	1.1.2006	31.12.2004	31.12.2000
Total area km ²	83 971	43 261	45 237	338 144	41 543	323 502	462 236	41 285
Land area km ²	82 132	41 238	42 284	334 473	37 253	324 242	431 132	38 882
Population	8 248 324	5 411 035	1 075 252	5 208 811	16 305 524	4 906 242	9 111 582	7 686 007
Population grid dataset	7 764 849	5 244 420	1 387 872	5 188 217	16 305 524	4 897 482	8 889 271	7 328 273
Population in grid cells per cent	94,2	98,7	100,0	100,0	100,0	98,2	97,6	100,0
Inhabited grid cells	42 942	39 126	21 723	102 866	29 988	69 654	118 216	19 268
Inhabited grid cells - per cent of total areas	51	31	31	31	40	16	26	46
Inhabited per km ² area	101	138	63	60	644	13	27	178
Area population in one grid cell	26 895	21 684	17 382	17 232	21 176	15 197	23 382	23 237

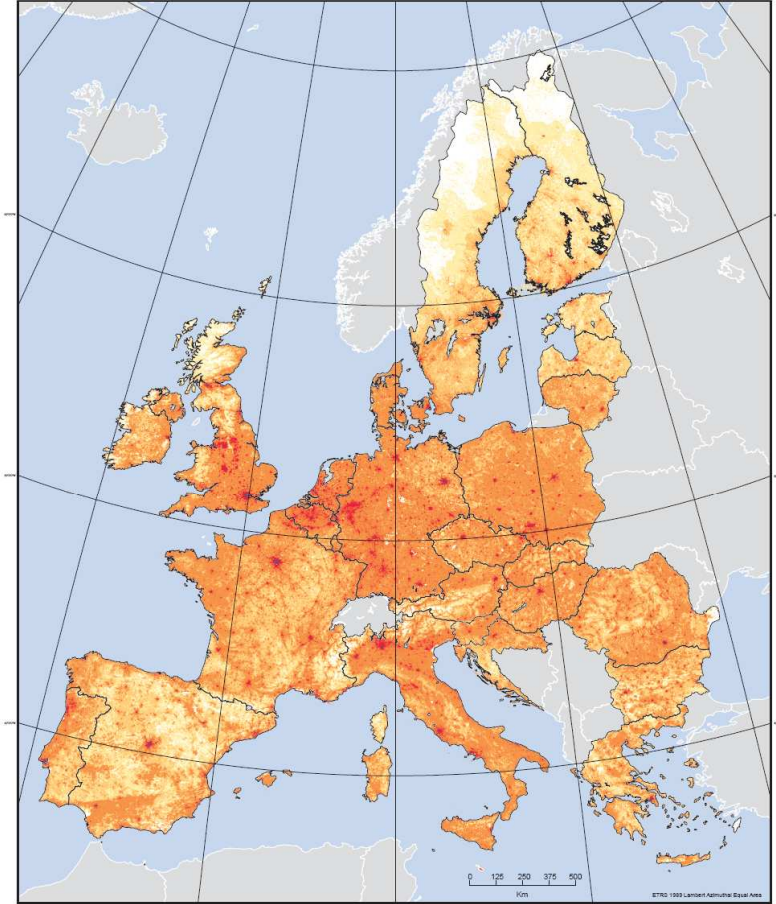
Statistics: National Statistical Institutes
Geographical features: © EuroGeographics for the administrative boundaries

Inhabitants per individual square kilometre

- 1 - 4
- 5 - 19
- 20 - 199
- 200 - 499
- 500 - 4 999
- 5 000 -
- Uninhabited

Map composed by Statistics Finland 9/2006.

Population by 1 square km grids (estimated)



Population data based on disaggregation of population at LAU2 level through Corine Land Cover 2000 data to square km grids.

Data source: European Commission - JRC
Geographical features: © Eurogeographics for the administrative boundaries
Map composed by Statistics Finland 9/2006.

Estimated number of inhabitants per individual square kilometre

- 1 - 4
- 5 - 19
- 20 - 199
- 200 - 499
- 500 - 4 999
- 5 000 -

Figure 3: The Geostat “ESSgrid” “Bottom – up” (Left) and “Top – down / Hybrid” 2008 version (Right)