MEASURING THE WEIGHT OF THE WORLD
A Research Proposal

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ABSTRUCT

Although there are many international statistics on economic production flows (e.g. GNP), there are no comparative data on social material capital. Such data has never been collated and compared, let alone analyzed and synthesized. This omission leaves a significant lacuna in understanding the impact of the cultural **World** socio-system, distinct from but built upon a surface of the natural **Earth** planetary ecosystem.

This article presents a project to correct that problematic situation by measuring the physical aspects of the Global Society, expressed as the **Weight of World (WoW)**. By discovering certain fundamental traits characterizing social systems, it will relate their economic, political and cultural sectors, as well as their natural environment, in synchronic comparison and diachronic history.

Eventually, new information will be given primarily by means of a **Gross National Mass (GNM)** for each city, country, and region of the world. The data thereby accumulated, when summarized and analyzed will present a more complete picture of the world, thus enabling social scientists and decision-makers to improve their knowledge of the international system and act accordingly.

To measure the GNM, the sociophysics paradigm will submit its conceptual framework and mathematical formulae. This statistical quantitative methodology will construct and apply a **Socio-Physical-Index (SPI)** as central measure of each country's GNM, compared to its GNP. SPI will reflect the sum of the mass of humans, as well as their possessions and creations, by estimating and quantifying existing data from various sources.

The end product could be a published as an annual report on the state of the world, collating, tabulating and commenting on the detailed **SPI** of each country, as well as the correlation it has on important economic, ecological and political indicators.

N.B. Although the main text of this paper was a chapter in **Sociophysics** (1993 & 2005) it was edited and updated to fit this research proposal during the Ides of March, 2016.

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INTRODUCING THE SOCIOMASS INDEX

One of the surprising omissions in the social sciences is the measurement of social mass. This means that we do not know how much society as a material system weighs. The reason for our ignorance of this respect may be that such information is not considered important or that it is too difficult to calculate. Perhaps these reasons were valid in the past but with the increasing complexity of the world, knowledge becomes more necessary and possible now.

Decision-making requires as much information as possible in all fields of action, so it behooves us to fill this gap of knowledge so as to improve our capacity for problem-solving. Measuring the material constants and variables of society is absolutely and relatively important in approaching a whole picture of our position at any space and time.

This article introduces the significance of material aspects of social systems in the life of humanity. In doing so, one need not ascribe to crude materialism. On the contrary, it is recognized that matter is only one manifestation of existence. Social systems are a small part of material reality but they add to it by their attributes and help us in developing a better life.

The most characteristic quality of matter is mass. So much so, that the terms matter and mass are almost synonymous. Yet there is a difference, since mass is only the substantial part of matter, the rest is space. Since anything which has mass can be clearly distinguished from void, material objects can be identified because they fill a certain definable space. Matter obeys Pauli's exclusion principle in that it occupies a certain space exclusively and therefore resists the simultaneous occupation of the same space by anything else. This resistance persists over time, thus asserting the identity, stability and exclusivity of things relative to each other.

The thesis that social and physical systems are similar in significant respects is primarily based on their common materiality. As such, both share the attributes of mass which determine many of the similarities or differences between them and thus place each in a comparative perspective.

An obvious difference, of course, is number and size: material bodies are much more numerous and spread over a much broader range than human societies. Elementary particles are usually found in molar quantities containing over 10^{23} atoms (Avogardo's number), whereas the number of human beings (over seven billion) has barely passed the halfway mark to 10^{10}. Social systems occupy a very small portion in the middle range of material existence. In spite of these sizable quantitative differences all material systems are remarkably similar in their structural qualities.

The **Sociophysics** paradigm provides the best foundation upon which its theoretical foundations applied to a practical measure of the Weight of the World (WoW). By focusing on the physical aspects of society, this approach looks at a neglected aspect of social science, whose importance has been seriously underestimated. In order to fill this gap, we should study the significant similarities between physical and social principles and processes.

Of course, part of these social aspects are traditionally measured by the famous Gross National or Domestic Product (GNP & GDP) of each country and the overall Gross World Product GWP, each year. But these controversial indexes only measure the economic flow differences and not the existing material stock of any country or the world. Yet in measuring this neglected aspect of society, not only adds to economic data, but improves policy-making and cultural comparisons, thus completing the three dimensional frame of the primordial SET (space-existence-time) parameter of sociophysics.

On that basis, a human **society** may be simply defined as a supra-organic system or a complex set composed of three kinds of entities: human subjects; appropriated objects; manufactured artifacts. As such, social systems combine organisms and mechanisms, or natural and artificial components. Of course, these are only the material aspects of society in which we focus here and leave the remaining aspects (status and roles) for other studies. These material components of the social system are equivalent to the elementary particles which make up an atomic system. As we ascend the levels of being from atomic to social, matter manifests different and more complex patterns. Nevertheless, its basic properties (i.e. size, position and impact) remain in space and endure in time.

The source of these similarities is the innate characteristic of matter to possess its three primary attributes: mass, motion and charge. The varying measures of these characteristics identify all material systems and their components. This article will only discuss mass, as the primary aspects of both atoms and humans and the important similarities that they share. The following three sections will discuss the SET aspects of reality as far as mass is concerned.

Social Mass: Demography

Our primary project now is to determine the WoW, as the existential gross physical mass of the global human society as the total of every country in the world. Here it is proposed to create a Gross Sociomass Index GSI that measures the WoW as the total of every Gross Social Mass (GSM) Index of each country. The social system, whether it is local, national or global, is therefore similarly measured by its sociomass.

This **social mass** is the weight of society that is simply defined as a supra-organic system or a complex set composed of three kinds of interrelated and interacting realms:

-<u>Humans</u> actors: population who creates, belongs and operates social systems;

-<u>Natural</u> Objects: possessions appropriated, cultivated, or domesticated by humans;

-<u>Artifacts</u>: goods, tools manufactured, constructed, produced and consumed by humans.

As such, social systems combine organisms and mechanisms or natural and artificial components. The material aspect of society manifests itself in complex patterns, but their basic properties (size and mass, position and duration) take up some space and last for some time. The source of these similarities is the innate characteristic of matter to possess its three primary attributes: mass; motion; charge. The varying measures of these characteristics identify all systems and their units.

First and foremost, the social system **sociomass**, defined by the totality of a human group, together with its natural and artificial possessions (i.e. population plus stocks and commodities), emphasizes the material constituents of society, distinguished by three criteria: human, artificial and natural (HAN). In symbolic terms, this means that sociomass (m_s) is a function of people (h), their livestock of animals or plants (n) and structures or artifacts of goods or tools (a).This relationship could be shown as the following equation, where "b" is the mass-weight-number parameter for each factor.

$$\mathbf{M_S = f(h,a,n) = b_1h+b_2a+b_3n}$$

According to this formula, one can calculate the mass of any social system as the weight of its population and possession. This formula makes it possible for such disparate things to convert into a single measure corresponding to their weight in tons or kilos.

The weight of humanity was easily calculated to be about three hundred million metric tons or thirty billion kilos ($3x10^{10}$). A rough estimate could be made for the non-human social **biomass** of domesticated animals and cattle to be about a trillion kilograms (10^{12}). Thus, the weight of world civilization has by now surpassed that of all life on Earth, estimated to be in the order of $10^{17,}$ while the stock of inorganic artifacts and structures would be over a quadrillion tons (10^{18} kg). Our distinction between the **World** (social system) and the **Earth** (natural ecosystem) is therefore very important. As large as these figures appear, they are puny compared to the weight of our natural environment: planet Earth mass being about 10^{25} kg.

The three components that make up the sociomass index are important in distinguishing its quality as well as quantity. Although sociomass is determined by its environmental resources and system efficiency; the ratio between the human mass and its material goods **(h/m**) would indicate the wealth or prosperity of the social system. Similarly, the ratio between natural and artificial mass **(n/a)** would indicate its development or technology. In this way, the condition and development of human societies at all levels can be standardized and uniformly compared in space or time.

Social systems are open, because they exchange materials both with the natural environment and with other social systems. The net matter in a system at any time is its original mass, plus any additional input, minus any possible output. Once the borders between the system and environment have been set, if open systems are to maintain a constant mass, they must balance their transaction accounts.

A demographic equilibrium through time is a major factor in stabilizing sociomass. Such equilibrium depends largely on the ratio between fertile and infertile parts of the population. A good ratio for stability is 30% young; 60% adult and 10% old people. Given a constant fertility rate, a higher percentage of young will result in an eventual population increase as the contrary will lead to a decrease.

Although traditional societies are in general equilibrium, modern social systems always have a net positive inflow of matter. This means that sociomass is steadily increasing at the expense of nature, since that is where the additional mass is coming from. Because the Earth is a closed system, its constant mass gradually shifts from the natural to the social realm. Thus, contemporary social systems are continuously appropriating natural resources, transforming them into social commodities.

Social Space: Geography

Since spatial extent is the most significant trait of mass, we now consider the spread of mass or number of units in space that measures the density of society. The importance is this measure is evident because social index of any population is density-dependent. Social space comprises a certain inhabited region along with its pastoral-agricultural territory and other utilized land, water and air. This area is usually so well defined as to form a geographical entity with distinct borders.

In general, the **size** of societies depends on the availability of people, resources and space. In any particular case, the optimal sociomass will be the result of these three factors. As a rule, any society will expand to fill the space and exhaust the resources available to it. Since the ratio between mass and space determines the state of the system, dense societies require solid structures, whereas small-light populations in large-empty spaces are more fluid or diffused.

Since both territory and resources are in limited supply, there are certain constraints as to how massive or dense a society can be. So-called scale effects set the upper limit to the size of all material systems. Since weight triples as distance doubles, mass rapidly becomes so heavy that it can no longer support its weight. What works for a certain size then may fail for another.

Concentrations of mass in definite spaces form individual objects, which may be of various sizes (big or small) and numbers (few or many). The number and size of objects contained in a certain space determines the **density** (d) of a substance, which equals its mass (m) per unit volume of space (s) it occupies. In symbolic language this is noted as:

$$\mathbf{d=m/s}$$

This proportionality shows that the density of a system increases along with the size and number of its units, whereas it decreases with the space available for them. This varying density determines the three **states** of material systems: solid; liquid; and gas.

-Gaseous: Pastoral, nomadic, roaming hunter-gatherers.
(50 person tribe, moving within a 500 square mile area);
-Liquid: Agricultural, rural, settled land-cultivators.
(5,000 person community living within a 500 square mile area);
-Solid: Industrial, urban, collective mass-habitats.
(500,000 person city, residing within a 500 square mile area).

This distinction seemed so fundamental to the ancients that they considered it elementary. The three Pre-Socratic philosophers of Miletus (6th C.B.C.) saw the essence of reality in three elements: Anaximenes in air, Thales in water and Anaximander in earth. Now, of course, we recognize that these differences are due to more basic elements and their state of density.

This means that the structure of matter differs according to its state: solids have the highest density; whereas gases have the lowest; with liquids in between. Because of their density, the components of solids and to a lesser extent liquids occupy completely the space available to them, whereas those of gases are too diffuse to do so.

Although a certain density is necessary for social structure and division of labor, a large sociomass in a small territory has certain advantages and disadvantages depending on its ratio of people and goods. A dense urban society supported by high material mass would compare favorably with a dense society of little material support or a sparsely populated poor rural region.

On the basis of these attributes of mass, one is able to distinguish material bodies from clouds to humans. Such identification is adequate for our purposes of comparison between physical and social systems at this time, leaving for later other characteristics. We can then pass directly into the social analogy based solely on these simple attributes.

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In this respect, there are three states or types of social systems: gas; liquid; solid**.** Naturally, like atoms, societies are not evenly distributed in space. There is usually a nucleus or center which contains most of the mass of the system; be it a village, town or city. The more complex the system, the greater the concentration of its mass in a core region and the greater the density differentials between urban and rural sociospace.

Since both territory and resources are in limited supply, there are definite constraints as to how massive or dense a society can be. So-called scale effects set the upper limits to the size of all material systems. Since weight triples as distance doubles, masses rapidly become so heavy that their materials can no longer support their weight. What works for a certain size, then, may fail for another.

Based on Galileo's Thesis of Dimensional Forms, there is a maximum size to any system, beyond which it would collapse of its own weight. In that case, a society that gets too large would break down into a number of more viable sized units. Conversely, there is a lower limit to viability. A minimal or critical mass is necessary for the perpetuation of any society. Most societies, therefore, range above the minimum of the nuclear family and below the maximum of the entire species.

Since Plato, many thinkers tried to determine the size of the ideal society. The platonic number of about 5000 citizens for the classical polis, is, of course, limited by the historical, material and cultural circumstances of his place and time. Similarly, it is said that the ideal size of a working group is between six and twelve people. The appropriate size is, therefore, determined by a multiplicity of other factors below.

Social space comprises a certain inhabited region along with its pastoral-agricultural territory and other utilized land, water and air. This area is usually so well defined as to form a geographical entity with distinct borders. Traditionally, geopolitics focuses the relations between natural space and national power. Here we go deeper by investigating social mass, as defined above, and spatial variables.

Naturally, societies are not evenly distributed in space. There is usually a nucleus or center containing most of the mass of the system; be it a village, town, or city. The more complex is a system, the greater the concentration of its mass in a core region and the greater the density differentials between its urban and rural **sociospace**.

Social Change: Historiography

This variation brings us to the consideration of time as a variable, along with space. Beyond the comparative aspects of geography, we thus have the diachronic aspects of history or specifically how sociomass changes in time **(m/t).** As the juxtaposition of physical and social systems has allowed us to make some significant comparisons between the fundamental properties of their masses, we can now conclude this article by introducing time and its impact in mass.

In this discussion we begin by addressing the primordial conservation laws, the primary of which is the Conservation of Mass, which states that the total mass of a closed system is always preserved. Since mass is an extensive property of matter, it must be conserved in all physical transactions. In mathematical language this law is written as:

$$\Delta m/\Delta t=0$$

This means that the change of mass (Δm) during a certain period (Δt) must be equal to zero. Since a closed system, as the Earth, per definition, does not exchange matter with its environment; this law means that matter can neither be created nor destroyed, but only displaced or transformed within the system.

Social systems, as the World, however, are open because they must and do exchange materials at least with the natural environment, if not with other social systems. Nevertheless, these imports and exports do not invalidate the law that that all material transactions must be accounted for. The net matter in a system at any time is its original mass, plus any additional inputs, minus any possible outputs. Once the borders between the system and environment have been set, if open systems are to maintain a constant mass, they must balance their transaction accounts.

Demographic equilibrium through time is a major factor in stabilizing sociomass. Such equilibrium depends largely on the ratio between fertile and infertile parts of the population. A good ratio for stability is 30% young; 60% adult and 10% old. Given a constant fertility rate, a higher percentage of young will result in an eventual population increase; the contrary, a decrease.

Although traditional societies are in general equilibrium, modern social systems always have a net positive inflow of matter. This means that the sociomass is steadily increasing at the expense of nature, since that is where the additional mass is coming from. Because the Earth as a whole is a closed system, its constant mass is gradually shifted from the natural to the social realm. Thus, contemporary social systems are continuously appropriating natural resources which they transform into social commodities.

As societies become more massive, however, they fall increasingly under another law, that of Conservation of Inertia. Mass and inertia are so closely identified that they may be part of the same definition. It is said that mass is anything that has inertia: an attribute which resists change. Inertia, thus, accounts for the conservative tendency of matter. Newton's First Law reflects the tendency of all things to maintain their state of being, whether this is rest or motion. This natural preference for the *status quo* was also remarked in Leibniz's Law of Continuity which proclaimed that *natura non facit salta.*

This resistance to change increases with mass, so that it is more and more difficult to move societies as they become heavier. As an example at the simplest level, nomadic societies turn into stationary ones or break up when they attain their upper critical mass (more than a thousand people). At a higher level, inertia manifests itself in subtler ways. In any case, the innate resistance of mass imposes itself on all material systems. Of course, it is always possible to overcome this inertia. But as we move from statics to dynamics, other laws come into effect.

One such law is that of thermodynamics, whose second law is that of **entropy,** as the arrow of time in all natural phenomena. As closed systems tend to enervate, disorder and degrade so do societies, unless external flows of matter and/or energy are infused into them. Environmental inputs are therefore continuously necessary to maintain social integrity and cohesion, let alone develop social structures and functions.

Social development is reflected in historical progress when communities rise towards greater levels of matter, energy and information. The historical trend from **Pastoral** through **Agricultural** to **Industrial** systems has recorded the evolution of increasing space, mass, and density to human societies in decreasing periods of time.

As different countries in different stages of their development have a different sociomass, measuring this mass and its correlates should therefore give a good idea of a country's physical status and its relative standing among its peers at any particular time, as well as throughout history.

As for the future, all this additional weight of social systems is necessarily imported and subtracted from the natural environment, while the entropic detritus of civilization is dumped and added back into nature. So far, this has been possible because the largesse of nature was able to support, digest and recycle such transfers. How long can this go on is a question that further study may help answer. Hopefully, **Post-Modern** systems will find a way to create a sustainable nature-culture coexistence.

In this search, estimating the comparative weights of different societies in space and time will add one significant factor to the plethora of other ones we already have. Furthermore, the heuristic possibilities of finding correlations among these variable indices should increase knowledge in system interactions and thus advance social science in general as well as economic and political science in particular.

The relationship between nature and culture has been as long as the classic *nomos-physis* controversy. Since then, its modern version was the positivist configuration of physics and politics. With the recent advances of general, chaotic and complex systems theory, post-modern development tends towards the interdisciplinary convergence of natural and social sciences, within which social science can advance on a broad front.

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