SOCIO-PHYSICOCHEMICAL THEORY [N1]

Part-1: Theoretical Considerations

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Mirza Arshad Ali Beg
arshadalibeg@gmail.com
Research& Development Consultants
Karachi 75210, Pakistan

Abstract

Socio-Physicochemical Theory and its implications have been enunciated. The theory is based on the principles of Physicochemical approach to human behavior (1) and the concept of social pollution (2), which provide new dimensions to the understanding of processes of degradation of human and physical environment[1,2,3]. The Theory holds that while materials cycle in ecosystems, energy flows through their hierarchies for example the Celestial → Global → Macro → Micro → Nano- → Pico- → sub-pico- systems. Energy that powers socialization processes follows Gibbs Free Energy equation: $\Delta G = \Delta H - T\Delta S$, by analogy; it states that during transfer of energy into different ecosystems the internal energy or enthalpy (ΔH) in the Free Energy equation decreases and entropy (ΔS) increases in each system.

A specific quantum of energy, on dispersal in an interactive process such as isothermal gas expansion/ chemical reactions, or socialization (by analogy), will be subject to modification/degradation or to entropy change given by ΔS. Entropy change in social interactions is, by analogy, a measure of how a specific amount of social empowerment is dispersed in an interactive process, such as those parallel to gas-liquid and solid mixing; reversible heating, phase changes, and chemical reactions.

Internal energy of a community settled in an isolated ecosystem will, in socio-physicochemical terms, remain constant since there will be no input of energy and also existing energy content will neither create additional quanta nor destroy what is available. A communal system under equilibrium conditions with $\Delta G = 0$ will have no tendency to modify or transform its resources since the forward and reverse reactions among community members are in balance, suggesting that its entropy is optimized. The community will however, gain or lose energy through interaction with the surroundings e.g. by using up its internal energy implying modification and/or depletion of the internal resources, or during interaction with another system in the surrounding.

Spontaneous changes being generally exothermic are accompanied by large amount of heat and excessive randomness (ΔS) in addition to correspondingly large driving force (ΔG). Thus, it is difficult to have an ordered state in a heated atmosphere, or in agitated social gatherings charged with emotions with $\Delta G < 0$ and high values of $T.\Delta S$. This argument suggests that the forward reaction that yields useful product and brings order in a society is dominated by negative forces that can reverse the process and establish disorder. It further suggests that ***order and disorder can co-exist but their balance needs to be sustainably managed so as not to allow entropy to dominate over enthalpy, and also to optimize reduction of enthalpy to sustenance level.***

Considering the location of resource-poor countries in the high heat zones, where intense heat and high aridity cause widespread degradation in the physical environment, it is assumed that the region would be under oxidative stress. Processes introduced for development of the region, such as those represented by equation (15), would use up available resources, decrease the enthalpy component of Free Energy equation (4) and decrease ΔG, the driving force of the system and hence its population. The catastrophic end of the exploitative activities lies in the resources being irreversibly fixed as assets, never to be available to the region from where they were removed. Exploitation of the meager resources of the Earth has in the above context irreversibly degraded the quality and depleted the potential of the ecosystem with respect to key elements viz. water, soil, and vegetation that serve as the natural foundation for human existence.

Processes of degradation of resources are rampant all over the world. They push the resources to impoverishment and the ever growing population to poverty. The affected population develops fugacious tendencies and migrates for its livelihood to urban centres, which are not prepared to absorb it. Exploitative situations are cause and consequence of impoverishment of resources, for alteration in the order and quality of socio-physicochemical structure, and lead to emergence of class structure in that the

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exploiting class skims out as the beneficiary by getting richer with increasing exploitation followed by stress situation in the rest of the social structure. The circle of resource impoverishment is never complete; it completes partially though, when the exploiters get command of the situation and completely exhaust the resources.

Introduction

Socio-Physicochemical Theory is based on the principles of ecosystem approach to socialization processes. The theory holds that while materials cycle in ecosystems, energy flows through their hierarchies for example the Celestial → Global → Macro → Micro → Nano- → Pico- → sub-pico-systems. Stellar bodies, the living and non-living systems generally depend on adequate amount of energy and supply of materials which flow from the higher hierarchies to the lower to support the socialization processes.

Different ecosystems have different catabolic-anabolic-assimilation efficiency which itself depends on the compatibility, interdependence and socialization of different components of the ecosystems. Socialization in ecosystems has developed with diversification of different components and their number or population. The relative abundance of different species of plants in ecological communities including forests and grasslands is due in part to availability of defensive compounds in the different systems.

Energy that powers socialization processes follows the Gibbs Free Energy equation: $\Delta G = \Delta H - T\Delta S$, which states that during transfer of energy from celestial → macro → micro → nano → pico → sub-pico ecosystems the internal energy or enthalpy (ΔH) in the Free Energy equation decreases and entropy (ΔS) increases in each system. In life processes energy flow follows the natural pathway: production → consumption → assimilation → non-assimilation → losses (feces), and respiration. In the mean time enthalpy decreases and entropy increases as heat loss during catabolic-anabolic-assimilation, movement, decomposition and other processes involved in stress-strain relationship.

Socio-Physicochemical theory regards free energy as the power driving interactions and processes, whether chemical, biological or social for their completion and product formation. A reaction between A and B is said to be in equilibrium in physicochemical terms when the rate of forward reaction to form AB and backward reaction, or dissociation into A and B is in balance:

$$A + B \rightleftharpoons AB \qquad (1)$$

In equation (1) the forward process dominates over the reverse process and the reaction forms just as many ABs as are dissociated into A and B. In Socio-Physicochemical terms the forward reaction processes do not go to completion in the above simple and ideal form, and additional entities such as those in equation (2) are formed during the socialization process:

$$A + B \rightarrow AB + ABB + AAB + BA + ABA + BAB + \ldots\ldots \qquad (2)$$

The formation of entities viz. AB, BB, AA, BA etc. other than just AB is at the cost of useful energy and constitutes energy wasted. This is described in Gibbs Energy (G) terms as follows:

$$G = (U + PV) - TS \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where U is Internal Energy, TS is absolute temperature x final entropy, and PV is pressure x volume

(U+PV) in equation (3) can be defined as: (U+PV) = H, where H is enthalpy.
Gibbs Energy is thus related to enthalpy by the following equation: $G = H - TS$

The change in Gibbs energy is given by $\Delta G = \Delta H - T\Delta S$ …….. (4)

Equation (4) was arrived at by considering the equation for the total entropy change of the universe:

$\Delta S_{universe} = \Delta S_{microenvironment} + \Delta S_{macroenvironment} + \Delta S_{global\ environment}$ … (5)

$\Delta S_{universe} = \Delta S_{system} + \Delta S_{surroundings}$ …… (6)

$\Delta S_{surroundings}$ can be rewritten as $\Delta H/T$; the heat, q_p, the system which affects the surroundings is the negative of the ΔH for the system. Because $-qp = -\Delta H_{system}$, the change in entropy of the surroundings will be $\Delta S_{surroundings} = -\Delta H_{system}/T$. The equation becomes:

$$\Delta S_{universe} = (\Delta H_{surrounding}/T) - \Delta S_{system} \text{ ……..} \quad (7)$$

Multiplying both sides by T the equation becomes

$$T.\Delta S_{universe} = \Delta H_{surrounding} - T.\Delta S_{system} \text{ ……} \quad (8)$$

Since $\Delta G = \Delta H - T\Delta S$

$\Delta G < 0$ indicates a spontaneous* change to occur.

$\Delta G > 0$ indicates absence of spontaneity.

$\Delta G = 0$ indicates a system at equilibrium.

Gibbs Energy reaches the minimum value when equilibrium is reached. It may be mentioned that ΔG is the energy available to be converted to work. This definition is self evident from equation (4) derived earlier:

$$\Delta G = \Delta H - T\Delta S \text{ ……..} \quad (4)$$

Here ΔH is the enthalpy or internal energy that can be converted into potential energy, kinetic energy, electromagnetic radiation and/or phase changes. $T.\Delta S$ is the energy that has been worked out and hence not available to be converted to work.

Expressed in words:
(Total Free energy) = ΔH (Energy available for conversion) – (energy worked out/not available)
Thus ΔG is the energy free to do work, and ΔH is enthalpy or internal energy.

Helmholtz Energy is related to Gibbs Energy as follows:
The Helmholtz Energy (A) is given by the equation:

$A = U - TS$, which is comparable to Gibbs Energy:

$G = A + PV$ …….. (9)

The Helmholtz Energy is used when having a constant pressure is not feasible. Along with internal energy and enthalpy, the Helmholtz Energy and Gibbs Energy make up the quad group called the thermodynamic potentials; these potentials are useful for describing different thermodynamic events.

Gibbs free energy ΔG, while combining enthalpy and entropy into a single value, predicts the direction of the chemical reaction under the conditions of constant temperature and constant pressure. If ΔG is positive i.e. $\Delta G > 0$, the reaction is non-spontaneous (requires external energy to induce interaction) and is not favoured. When ΔG is negative i.e. $\Delta G < 0$, it is spontaneous (occurs without external energy input). The situation just stated can be described in terms of free energy as follows:

$\Delta G < 0$ favoured reaction (Spontaneous)

$\Delta G = 0$ forward and reverse reactions are in balance

$\Delta G > 0$ unfavoured reaction (Non-spontaneous)

Any change in a system at equilibrium at constant temperature and pressure is such that the free energy remains constant. This then provides an answer to the question of how the drive towards maximum entropy and the drive toward minimum energy reach a compromise as a system strives towards equilibrium. *From the above equations it is evident that increase in entropy (S) and decrease in enthalpy (H) both tend to lower the free energy of the system*. Therefore the criterion for equilibrium would be to have T and P constant so that the change in free energy ΔG is a minimum. Similarly for Helmholtz free energy (A), the equilibrium condition at constant temperature and volume would be to have T and K constant so that change in Helmholtz energy ΔA is a minimum.

Socio-Physicochemical Theory & Parallels with Thermodynamic Principles

Socio-Physicochemical theory regards Energy of all types: the kinetic energy involved in phase changes of molecules; potential energy of molecules in fusion; electromagnetic radiation, as well as latent heat of vaporization and condensation, to disperse in universe while the energy remaining unutilized is considered as worked out and being non-available is converted to entropy. A specific quantity of molecular energy, on dispersal in an interactive process such as isothermal gas expansion/chemical reactions, or socialization (by analogy), will be subject to modification/degradation or to entropy change given by ΔS. Entropy change in social interactions is, by analogy, a measure of how a specific amount of social empowerment is dispersed in an interactive process, such as those parallel to gas-liquid and solid mixing; reversible heating, phase changes, and chemical reactions.

Changes in Enthalpy during Spontaneous Reactions

Enthalpy is described as the thermodynamic potential of a system; it is used to estimate the useful work obtainable from a closed thermodynamic system under constant pressure and entropy. The equilibrium constant in equation (5) may be rewritten for standard states by combining the constants in Boyle's law, Charles's law, Avogadro's law, and Gay-Lussac's law as follows:

$$-RT\ln K_{eq} = \Delta H^{o} - T.\Delta S^{o} \ldots\ldots \quad (10)$$

$$\text{OR} \qquad \ln K_{eq} = -\Delta H^{\circ}/RT + \Delta S^{\circ}/R \ldots (11)$$

Equation (11) suggests that the intensity and spontaneity of reaction given by K_{eq} depends on the balance between ($\Delta S^{\circ}/R$) and ($-\Delta H^{\circ}/RT$). The balance between enthalpy and entropy will be disturbed on rise in temperature, since alteration in temperature will change the reaction condition, for example its rate of reaction, intensity of spontaneity and state of aggregation. Thermal energy input will alter reaction condition and in each case the alteration will:

1) Induce oxidative stress whereby ΔG the free energy will be depleted, the driving force will tend to be minimum while the reaction will slow down,
2) Result in lowering the ΔH and increasing the ΔS, implying that the internal energy will yield to higher values of entropy,
3) Adjust the intra-molecular forces to sustain the molecular framework,
4) Change the orderly into a disordered state, and
(5) Put the status of compactness of the structure at stake.

In socio-physicochemical terms, the internal energy of a community settled in an isolated ecosystem, will remain constant since there will be no input of energy and also existing energy content will neither create additional quanta nor destroy what is available. A communal system under equilibrium conditions with $\Delta G = 0$ will have no tendency to modify or transform its resources since the forward and reverse reactions among community members are in balance, suggesting that its entropy is optimized. The community will however, gain or lose energy through interaction with the surroundings e.g. by using up its internal energy implying modification

and/or depletion of the internal resources, or during interaction with another system in the surrounding.

In all cases the value of Keq, the equilibrium constant, or *intensity of spontaneity* of communal interaction in socio-physicochemical terms will increase in equation (11) with consequent

a) increase in ΔS° (negative quantity), and
b) decrease in ΔH° (positive quantity).

This implies that the balance will be shifted to higher entropy values or randomness/ disorder on increase in standard ΔS° ($\Delta S^\circ \not R$) of the commune and decrease in standard ΔH° ($-\Delta H^\circ \not RT$), the internal energy or the resources of the system, thus instigation of any sort will induce stress, create disorder or randomness, increasing the entropy of the system in the meantime.

Increase in ΔS° ($\Delta S^\circ \not R$) will lead to decrease in the degrees of freedom in the communal system, since it will lower the internal energy ΔH° ($-\Delta H^\circ \not RT$) of the components i.e. the community members or intra-community forces in the macro framework, leading to increase in openness and decrease in compactness of the social system.

In general, the balance between $-\Delta H^\circ \not RT$ enthalpy and $\Delta S^\circ \not R$ entropy or between order and disorder cannot be achieved in the same system under any given set of conditions because entropy always tends to be maximum. Likewise forces that induce maximum depletion of enthalpy ($-\Delta H^\circ \not RT$), put the status of compactness of the social system at stake as in equation (5). Hence the free energy minimum (at constant T and P) representing the most satisfactory compromise can be attained and the disorder minimized by precautionary measures such as adoption of security procedures.

Endothermic reactions which are characterized by the need of energy input for carrying them out to completion or phase changes such as in crystallization or separation of crystals by cooling a solution provide examples of $\Delta G = 0$ having forward and reverse reactions in balance and lower incidence of disorder.

Change of Entropy & Changes in State of Aggregation

Entropy in Socio-Physicochemical terms is a measure of randomness of communities (social groups) like molecules in a chemical system and is central to the fundamental relations, which deal with physical processes and spontaneity of their occurrence. Spontaneous changes, in isolated systems, with no surrounding, occur with an increase in entropy; they have the tendency to smooth out/level off the differences in temperature (agitation, commotion), pressure (stress), density (compactness), and potential (driving force) that may exist in the system. Keq, the equilibrium constant, is therefore a measure of adjustment in response to the smothering process.

Production of Order from Disorder**:** Energy is released in exothermic **r**eactions; they have negative values of ΔH. Precipitation leading to micro-crystallization is a typical examples of exothermic reactions in which solids in crystal form, characterized as an ordered state are formed from disordered gaseous or liquid phases. In endothermic reactions, on the other hand, heat is consumed from the environment. This can occur by increasing the entropy of the system, often through the formation of gaseous reaction products, which have high entropy. Since the entropy increases with temperature, many endothermic reactions preferably take place at high temperatures. On the contrary, many exothermic reactions such as crystallization occur at low temperatures.

All spontaneous changes, because of the large driving force, bring in order by using the free energy for homogenizing the reaction/interaction. However, the reverse reaction sets in if the free energy is not utilized for homogenizing the forces of cohesion of different components, and ultimately results in large

entropy changes or randomness. Thus, it is difficult to have an ordered state in the social environment that is highly charged with emotions and is likened to a system that encourages dissociation or separation of species or else is disordered *per se*.

In spontaneous reactions there is extemporaneous degradation of energy, which results in lesser availability of free energy for useful work. This is similar to the leveling out of atmospheric temperature just past the blowing of wind; mountains and structures spreading out into plains or leveling out to conform to topography as a result of earthquakes, or solids slumping into semi-solids and subsequently melting to liquids. In each case there is decrease in the internal energy content and increase in randomness.

The processes involved in spontaneous reactions may be viewed as an ordered state yielding to random/disordered state. The reverse process of formation of an organized urban cluster/town from a slum may be regarded as precipitation of solids from liquids (random/disordered state), and the solids subsequently crystallizing into the typical crystal form as evolving order out of disorder as follows:

$$\Delta S = \Delta S_{liquid} - \Delta S_{solid} \quad \text{.....(12)}$$

An overall increase in Entropy is implied in the precipitation of solid out of the solution in liquid form as in equation (12). This may be because crystals forming an ordered system with large lattice energy also reduce the order in the liquid mass and thus further increase its randomness.

A slum that is home to a society or social groups in disarray, is like a liquid or a semi-solid, while one which is disciplined is analogous to crystals that have their components well structured. The former society has higher entropy as suggested by equation (12). The higher the value of ΔS the lower will be the order of aggregation or compaction of the crystal. Compaction in cubic crystals is likened to the higher state of order and discipline observed among advanced communities. Advanced societies have achieved this status by maximizing the exploitation of ecological resources, which implies lowering the internal energy content ΔH and hence maximizing entropy ΔS.

Compactness of societies is, in Socio-Physicochemical terms, a result of forces of attraction present among intra-species and inter-species, parallel to interatomic and intermolecular forces in a molecular framework. Existence of intra-species forces is demonstrated by the following comparison of Helium and Water:

1) The inert gas Helium (He), which exists as a monatomic gas at room temperature, forms gaseous helium (P=1 atm) above -269^o C. This is because the intra-molecular forces of attraction in monatomic He are extraordinarily weak; the gas has to be cooled to extremely low temperature of -269^o C to reduce the average thermal kinetic energy of its atoms and induce the formation of a condensed liquid phase.
2) Water with two atoms of hydrogen (H) and one of oxygen (O) bound together, liquefies at 100^o C and forms ice at 0^o C.
3) It is the absence of intramolecular forces of attraction in Helium, and provision of intermolecular attractive forces, induced by hydrogen bonding between water molecules, that raises the boiling point in comparison with its isovalent homologs viz. H_2S and H_2Se.

Energy input for boiling, or withdrawal for freezing, have no effect on O-H intra-molecular bond distance. It is assumed therefore that the forces which cause condensation of vapour and freezing of liquid are active between water molecules; they do not disorder the intra-molecular bonds. Accordingly water condenses at 100^o C while Helium requires cooling to -269^o C for condensation. This shows that it is the

presence or absence of intra-molecular forces that promotes compactness or openness respectively. Water molecules experience much stronger forces of attraction and hence liquefy and solidify much earlier than Helium atoms.

In the light of the principles of Socio-Physicochemical Theory compact societies have developed by enhancing interspecies and intra-species forces of attraction. Such developments have taken place at the expense of precious ecological resources that comprise the internal energy/internal resources. The development processes accompanying formation of compact (advanced) societies have decreased ΔH and increased the ΔS. This observation is in accord with equations (8 and 12) developed earlier, both of which are based on the fundamental principle that entropy of the Universe is on an increase:

$$T.\Delta S_{universe} = \Delta H_{surrounding} - T.\Delta S_{system} \quad \ldots\ldots\ldots\ldots\ (8)$$

$$\Delta S_{universe} = \Delta S_{suspension} - \Delta S_{solid} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(12)$$

Impoverishment of Resources: Decrease in $\Delta H \rightarrow$ Increase in ΔS

Spontaneous changes being generally exothermic are accompanied by large amount of heat and excessive randomness (ΔS) in addition to correspondingly large driving force (ΔG). Thus, it is difficult to have an ordered state in a heated atmosphere, or in an agitated social gathering charged with emotions with $\Delta G < 0$ and high values of $T.\Delta S$. This argument suggests that the forward reaction that yields useful product and brings order in a society is dominated by negative forces that can reverse the process and establish disorder.

$$Suniv = \Delta S_{disordered} - \Delta S_{ordered} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(13)$$

It further suggests that ***order and disorder can co-exist but their balance needs to be sustainably managed so as not to allow entropy to dominate over enthalpy, and also to optimize reduction of enthalpy to sustenance level.***

In the context of equation 8, 12 & 13, it would appear that order is carved out of disorder; crystals separate out from solutions and analogously development processes convert the macroenvironment into built environment thus using up the resources (ΔH) and inducing their depletion in the microenvironment. Further inferences drawn from equation (14 & 15) suggest that processes aiming at development are invariably cause for overall increase in entropy of the universe.

$$S_{univ} = \Delta S_{solution/suspension} - \Delta S_{crystals/solids} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

$$S_{univ} = \Delta S_{macroenvironment} - \Delta S_{built\ environment} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(15)$$

Several deviations in the quality of environment take place during the development processes, all of which aim at bringing order and minimizing disorder in the ecosystem. However, the process of development likened to solidification/crystallization, while bringing order modifies the microenvironment of the ecosystem, and separates out of the macroenvironment. This is likened to suspension/solution, out of which the solids/crystals are harvested. The former is in the state lacking order, implying a system whose enthalpy has decreased while its entropy is set to increase.

Impoverishment of Resources

Thermal energy input has been shown earlier to:

1) induce oxidative stress and deplete ΔG the free energy and the driving force which slows down the reaction, and

2) lower the enthalpy (ΔH), implying that internal energy yields to higher values of entropy and sets the ordered state to disorder depending on the intensity and spontaneity of the input may create chaos.

Considering the location of resource-poor countries in high heat zone area where the intense heat and high aridity causes widespread degradation in the physical environment, it seems reasonable to assume that region would be under oxidative stress. Processes introduced for development of the region, such as those represented by equation (15), would be exploitative in character. They will use up the available resources, decrease ΔH, the enthalpy component of Free Energy equation (4) and increase the entropy. They will additionally decrease ΔG, the driving force of the system and hence its population. An example at hand is the extensive excavation of sand and silt from the river bed to meet the urban demand for construction of villas. At Nethravathi River in India, the process has hit around 60 families living in Uliyakudru Island near Adyar, 10km from Mangalore in South India. Around 250-truck load of sand is being legally transported to Urban Bangalore daily on a government directive to meet the requirements of the rapidly growing construction industry set up there (http://timesofindia.indiatimes.com/city/mangalore/Adopt-uniform-sand-mining-policy-for-coast-Minister/articleshow/43968425.cms).

The catastrophic end of the exploitative activities lies in the resources being irreversibly fixed as assets, never to be available to the region from where they are removed. Exploitation of the meager resources of the Earth has in the above context irreversibly degraded the quality and depleted the potential of the ecosystem with respect to key elements viz. water, soil, and vegetation that serve as the natural foundation for human existence. The fragility of vulnerable ecosystems will be exposed to forces of degradation. In all such cases, K_{eq} in equation (10 and 11), which represents the balance between ($\Delta S°/R$) and ($-\Delta H°/RT$), and the Order – Disorder equilibrium such as in equation (13), will be greatly disturbed by the agents of change that induce oxidative stress and alter the orderly into a disordered system.

Processes of degradation of resources are rampant all over the world. They push the resources to impoverishment and the ever growing population to poverty while raising the entropy ΔS and decreasing the enthalpy ΔH. The resources having been impoverished, the affected population develops fugacious (escaping) tendencies and is induced to move on or migrate for its livelihood to urban centres, which are themselves plagued with high entropy (ΔS) and hence not prepared to absorb the migrants. The migration of population to the urban areas has amassed the urban clusters with social degradation and disorder by increasing slums (semi solid state) around the cities. This situation of disorder in the organized areas of the cities has, while creating law and order problems in the sociologically compact areas, misbalanced the order-disorder equilibrium given by K_{eq} in equation (11-13) and shifted it to higher disorder.

Exploitative situations such as the above are not only cause and consequence of impoverishment of resources, but also for alteration in the order and quality of socio-physicochemical structure. They, for example, lead to emergence of class structure in that the exploiting class skims out as the beneficiary by getting richer with increasing crystallization/exploitation (increasing ΔS) followed by stress situation (feeling of deprivation) created by impoverishment (lowering ΔH) in the rest of the social structure (equation 12, 13). The circle of resource impoverishment is never complete, since this game is one sided; it has no loser. The circle completes partially when the exploiters get command of the situation and completely exhaust the resources, while those feeling deprived either move out, since there is nothing for them to depend on, or precipitate out as Agents of Change to upgrade their status. The irreversible status of the degraded environment prevails nevertheless.

SOCIO-PHYSICOCHEMICAL THEORY

Part-2: Mechanism of Inducing Oxidative Stress

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Mirza Arshad Ali Beg
arshadalibeg@gmail.com
Research & Development Consultants
Karachi 75210, Pakistan

Abstract

Principles of Socio-Physicochemical Theory have been enunciated in earlier papers [1,2,3,4]. The Theory holds that Energy which powers socialization processes follows Gibbs Free Energy equation: $\Delta G = \Delta H - T\Delta S$, by analogy; it states that during transfer of energy into different ecosystems the internal energy or enthalpy (ΔH) in the Free Energy equation decreases and entropy (ΔS) increases in each system.

Earlier publications [1,2,3,4] have shown that changes following species interactions are in accordance with the Eternal Laws which suggest that the rate of forward reactions is proportional to concentration of interacting species and velocity of reaction, besides being dependent on the input of free energy (driving force) during forward reactions. Equilibrium is reached when the rate of forward reaction is balanced by reverse processes. The system in balance is said to have reached a *steady state*. Reverse processes slow down the interaction in the absence of input of free energy/driving force. In a steady state, energy is put into the system constantly to promote the formation of activated complex and to maintain a higher free energy state than at equilibrium. Communities of all living organisms have learnt to adjust to challenges of the extremes and to defend themselves from natural variables.

Energy input has been shown earlier to: 1) Induce oxidative stress and deplete ΔG the free energy and driving force which slows down the reaction, and 2) Lower the enthalpy (ΔH), implying that internal energy yields to higher values of entropy and sets the ordered state to disorder and chaos, depending on the intensity and spontaneity of the input.

Communal interactions are likened to endothermic reactions, with $\Delta G = 0$; they need input of energy for completion of reaction. Interactions of oxidants dominate over systems/groups with $\Delta G = 0$ or > 0, and deplete free energy of medium of interaction. Subjugating a system with diminishing driving force constitutes deeds of Social Pollution. Social Pollution invariably reduces ΔF, free energy/driving force during communal interaction.

Interaction among communities proceeds with a loss of at least one degree of freedom for alignment of the plane towards formation of activated complex and stable bond formation between two systems. Virulent communities overcome the inhibiting forces by first getting initiated and charged to form the activated complex AB* in the transition state in which structure is reorganized. Occurrence of minor or major changes in structure of the social system will depend on the potency of the stressor to induce losses in one or more or several degrees of freedom enjoyed by the society, organized or otherwise. Inadequately activated stressors will only produce metastable complexes which retard the process of product formation and slow down reaction rates.

Major changes are induced in spontaneous reactions which are generally exothermic; they are characterized by large driving force (ΔG) and excessive randomness (ΔS). With $\Delta G < 0$ and high values of $T.\Delta S$, such as in an agitated social gathering charged with emotions, it will be difficult to have an ordered state. Reactions/interactions with high rates of spontaneity are accompanied by sudden release energy which creates oxidative stress, and large increase in wasted energy or entropy. There is tremendous loss of resources during the oxidative stress induced in quest for dominating over another system or group. Degradation of resources by spontaneous reactions such as those initiated by warring communities are rampant all over the world.

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[1] Mirza Arshad Ali Beg, *New Dimensions in Sociology*, (Karachi: Hamdard Foundation Press, 1987),

[2] Mirza Arshad Ali Beg, *Democracy Displaced in Pakistan, Case History of Disasters of Social Pollution*, (Karachi: Research & Development Publications, 1998),

[3] Mirza Arshad Ali Beg, *Social Pollution & Global Poor Governance, Analysis of Psyche of Governing Hierarchy*, (Karachi: Research & Development Publications, 1999)

4. Mirza Arshad Ali Beg, Life Processes Health Aging & Disease, Ecosystem Approach to Life Processes, (Karachi: Research & Development Publications, 2011) ISBN:978-969 – 8492- 03 – 8

Introduction

It has been stated in earlier publications [1,2,3,4] that changes following species interactions are in accordance with the Eternal Laws which assert: 'All work and growth requires some form of energy input' and that 'Increased order (growth, complexity) in one part of a system is paid for through increased disorder (entropy) in another part.

According to Eternal Laws, the rate of forward reactions is proportional to concentration of interacting species and velocity of reaction. Interaction among species speeds up with time and input of free energy (driving force) during forward reactions. At a certain point of time equilibrium is reached and the rate of forward reaction is balanced by reverse processes. The system in balance is said to have reached a *steady state*. The reverse processes slow down the interaction in the absence of input of free energy/driving force.

Energy input into the system is necessary to adjust and maintain forward rate of reaction as well as equilibrium. Reverse reactions will otherwise set in. Maintenance of continuity in equilibrium has been described as *homeostasis*, which generally applies to dynamic systems that include local as well as global ecosystems. The living tissue in a tree, for example, maintains homeostasis, but a block of wood after it has been cut off from the tree will not and does not.

The postulates enunciated earlier advocate that all systems are most stable at their lowest free energy state under the given conditions. When that state is reached the system is in equilibrium. In a steady state, energy is put into the system constantly to promote the formation of activated complex and to maintain a higher free energy state than at equilibrium.

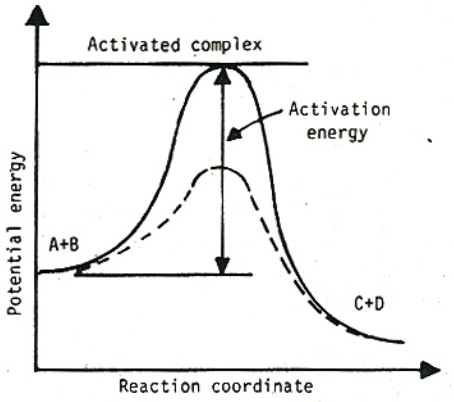


Fig. 1: Potential energy change during a reaction
(Dashed line refers to catalyzed reaction)

Features of Interactive Processes in steady state:

- Conditions are stable within the system
- Free energy is continuously put into the system to maintain the progression of the process
- Over a period of time, the system is maintained in a higher state of order than its surroundings

Features of Interactive Processes at equilibrium:

- Conditions are stable within the system
- Net free energy neither enters nor escapes the system
- Over time, any difference in entropy (state of disorder) between the system and the external environment tends to adjust and readjust

The adjustments taking place within the system maintain the equilibrium, while still meeting the prerequisites, can be shown as originating from the driving force of the essentials. Maintenance and survival can both be challenging because of the uncertainty that may not ensure continuous input of free energy. Communities of all living organisms have learnt to adjust to most challenges when faced with them. Additionally they have learnt to defend themselves from the extremes of variations in natural variables, for example heat and cold, rains and floods and the consequent divergence in availability of the essentials.

Human nature has been defined as the psychological activity set up in such manner as to maintain a steady state over gaining pleasure and avoiding pain [Mirza Arshad Ali Beg, *Chapter VII Adjustment, New Dimensions in Sociology*, A Physico-chemical Approach to Human Behaviour (Karachi: Hamdard Foundation Press, 1987]. The old theory that pleasurable is what is good, and painful is what is bad, would be interpreted in the present context as the dominant driving force ΔF, which leads to completion of reaction and interaction to satisfaction or pleasure while the preponderance of entropy factor ΔS would allow backward reaction, and produce a disturbance of equilibrium and may be painful. The disturbing/inactivating/deactivating process sets to pace the adjustment mechanism. The negative activity due to increase in entropy is restrained and the stresses appearing as pain and discomfort are suppressed. It may therefore be generalized that the positive driving force is generated when the process of reverse or backward reaction has been suppressed or has been overcome. Drive has accordingly been defined by the same postulates as the activity to remove pain or stress by adequate input of free energy, and the same has been assumed here as being responsible for different functions constituting life processes.

The above hypothesis that the driving force in an individual is the basis for removal of stress, so that equilibrium in the forward direction is maintained, finds support in psychology. The tendency of some persons to seek pain and misfortune is known in psychology as Masochism which in the present case is the tendency to seek reversal of equilibrium. It may be pointed out here that this is not an exception as may be true of other theories. On the contrary, this is a general case whereby the drive is aimed at perpetuation of pain or discomfort. Here it is the negative driving force which removes the stress and brings pleasure [Mirza Arshad Ali Beg, *Chapter VII Adjustment, New Dimensions in Sociology*, A Physico-chemical Approach to Human Behaviour (Karachi: Hamdard Foundation Press, 1987].

Some observations regarding the driving forces becoming dormant and reappearance may be attributed to the driving force ΔF becoming latent and the entropy factor ΔS becoming dominant. In the present context where drive is being assumed as the driving force, it might be possible to interpret the observed behavior in terms of fantasy, tension, stress and strain. The drive may remain dormant due to stress for some time and may return to active form on removal of stress or appear in active form at the generation of a specific stimulus. Earlier experiences which might have been dormant may strongly arouse the emotions in some specific environmental condition.

It is already known that reaction between many active moieties needs to be catalyzed. Reaction conditions have to be changed, for example by cooling or lowering the pressure of the system. Likewise stress situations and residual tension may persist either due to suppression of activity, reversal of equilibrium or inhibition of capacity to respond and react. The extent of inhibition of activity can be estimated from the alteration in frequency and intensity of the relapse of stress situations. It is also possible to evaluate the stress situation by a recently proposed method of measuring the level of stress hormones under different conditions.

Energetics of Communal Interaction

Energy input has been shown earlier to:

1) Induce oxidative stress and deplete ΔG the free energy and driving force which slows down the reaction, and

2) Lower the enthalpy (ΔH), implying that internal energy yields to higher values of entropy and sets the ordered state to disorder and chaos, depending on the intensity and spontaneity of the input.

Communal interactions are likened to endothermic reactions which need input of energy for carrying them out to completion. Phase changes such as in crystallization or separation of crystals by cooling a solution provide examples of reactions with $\Delta G = 0$ having forward and reverse reactions in balance and lower incidence of disorder. Interactions of oxidants designed to dominate over systems/groups that are deficient in driving force i.e. those with $\Delta G = 0$ or > 0, result in depletion of free energy of the medium/system of interaction. It has been maintained that attempts aimed at subjugating a system with diminishing driving force constitutes acts of acts of contamination of societies or deeds of Social Pollution. Useful energy described as ΔF (free energy or the driving force) of communal interaction, is composed of the terms: ΔH, enthalpy and T.ΔS the increase in entropy or randomness times temperature, given by the following equation:

$$\Delta F = -\Delta H + T\,\Delta S$$

This equation suggests that the greater the heat generated within the system, the larger is the randomness and disorder. There will be lowering of available free energy as well as driving force of communities charged with emotions and increase in oxidative stress during communal interactions. Contrarily the lower the heat generated, the lower will be randomness as observed in organized communities. Such communities will have higher free energy content and hence lower oxidative stress. They will have the capacity to act as oxidants and hence remove the free energy of communities with diminishing driving force.

It is well known that for a reaction to take place between components A and B free energy needs to be transferred from component A with large driving force or free energy ΔF to activate the component B to form an activated complex AB*. The activated complex AB* attains a higher energy potential as shown in Figure 1 and may remain in the excited state until its passage over the potential energy barrier and formation of a stable moiety AB with lower energy potential.

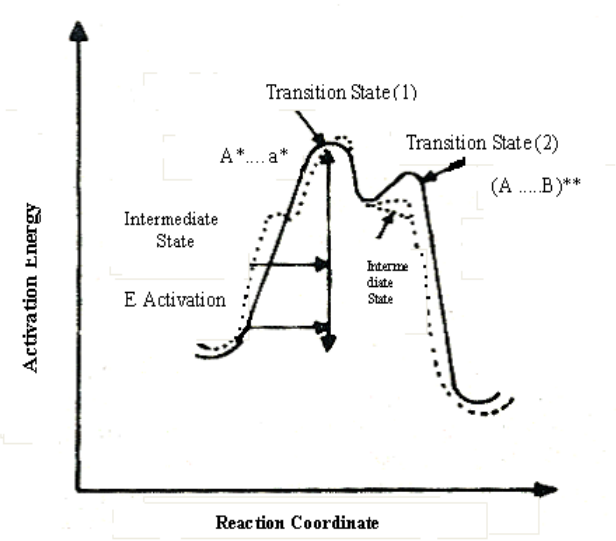


Figure 2: Potential Energy Diagram showing Transition States and Activated Complex Formation

At the metastable state (shown by humps in Figure 2) the reaction either does not take place or remains dormant till such time that it has attained the energy potential to cross over the energy barrier. Crossing of the barrier will push the equilibrium to the right in the potential energy diagram and thus satisfy the condition for formation of a stable bond between A and B [Mirza Arshad Ali Beg, *Chapter VII Adjustment, New Dimensions in Sociology*, A Physico-chemical Approach to Human Behaviour (Karachi: Hamdard Foundation Press, 1987].

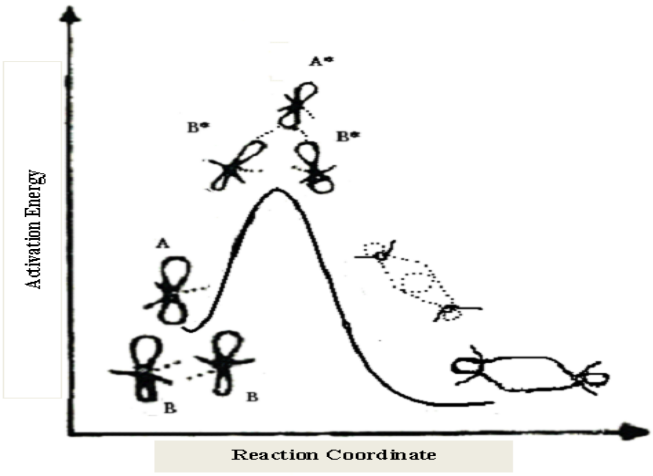


Figure 3: Activated Complex, Energy Barrier and Formation of Stable Bond

Communal interaction may proceed to equilibrium with a rate, which, in simple terms, is the number of (activated complexes)* passing per second over the top of the potential energy barrier (Energy of activation in Figure 1) and it equals the concentration of the (activated complex)* multiplied by the velocity with which the complex moves towards the product side, and separates out as hybrid communities. The reaction may be presented by equation (1):

A + B → (AB)* → Product (Hybrid Communities) ..... (1)

The rate of reaction is given by equation (2):

Rate = (AB)* x (rate of passage over barrier) ..... (2)

The process of interaction among communities amounts at the outset to loss of at least one degree of freedom since at this stage it initiates alignment of the plane of interaction. It would be possible for the reactant species to bring about bond formation so that the activated complex formed by interaction will result in a stable bond between the two moieties. The stability will also be determined by how much free energy is put in by the interacting oxidant moiety A to bring about the alignment of planes of interaction because the process of bond formation requires the crossing of the energy barrier as in Figure 3.

Virulent communities overcome the inhibiting forces by first getting initiated and charged to form the activated complex AB*. According to the postulates enunciated in earlier publications, the loss of a degree of freedom is followed by formation of the activated complex AB* in the transition state in which reorganization in structure occurs. The activated complex AB* is similar in all respects to a normal stable molecule except the difference that there is a loss of one of its vibrational degrees of freedom. A planar molecule assumes a pyramidal shape in the transition state, for example.

As per the postulates, this vibrational degree of freedom is transformed into a translational degree along the reaction co-ordinate which leads to disruption of the complex so that instead of 3_n - 6 vibrational degrees of freedom, a non-linear entity has 3_n -7 while a linear molecule with 3_n -5 degrees of freedom has 3_n-6 vibrations in the activated complex. What used to be one of the bonds holding AB* complex together, now simply becomes the line of centre between fragments separating as the hybrid as one of the products. Thus the Transition State Theory in Chemical Kinetics explains the interactions at community level just as well.

Minor changes in the microenvironment resulting from creation of stress situation; oxidative stress and oxidative dehydration removal of free energy by stressors, such as the oxidant moiety A from the system will entail losses in one or more or several degrees of freedom enjoyed by an organized society. Such situations demand adequate reversal by inducing replenishment of free energy. If, however, the activation energy is inadequate, the situation depicted by the dotted line in Figure 2 and 4 would be followed where there are humps even prior to reaching the stage of formation of activated complex. These humps are due to metastable complexes which retard the process of product formation and slow down the rate of reaction [Mirza Arshad Ali Beg, *Chapter VII Adjustment, New Dimensions in Sociology*, A Physico-chemical Approach to Human Behaviour (Karachi: Hamdard Foundation Press, 1987]

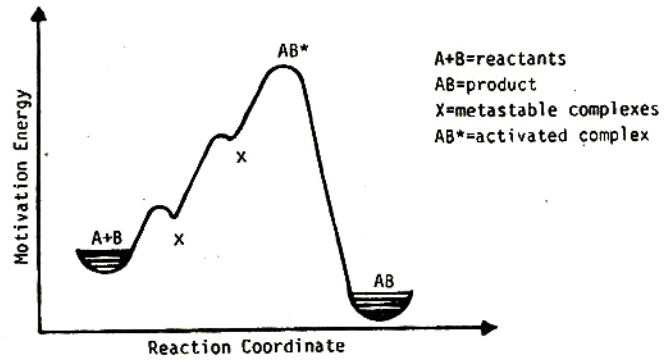


Figure 2.4: Mechanism of Reaction: Formation of Metastable states

Anti-bonding Energy

The barriers to formation of product are denoted by maxima and humps in the potential energy curves. The crossing of the barriers would be achieved through removal of the anti-bonding forces described by the theory of activated complex formation. If the anti-bonding energy is greater, the entropy factor will have a larger share and there may not be adequate free energy to drive the interaction among the components of the system to completion.

Formation of a stable bond between the virulent/invasive group and host community or formation of the hybrid community depends not so much on the energy of activation as on the energy required to hold the bond from breaking. In other words, it is the energy that is required to overcome anti-bonding. As required by the postulates, for a reaction to occur the anti-bonding energy must be lower than the bonding energy. A stable bond is formed when the anti-bonding energy is lower than the bonding energy.

Spontaneous reactions are generally exothermic; they are accompanied by large amount of heat and excessive randomness (ΔS) in addition to correspondingly large driving force (ΔG). Under the conditions with $\Delta G < 0$ and high values of $T.\Delta S$, such as in an agitated social gathering charged with emotions, it will be difficult to have an ordered state.

Reactions/interactions with high rates of spontaneity are highly exothermic; they are accompanied by sudden release energy that creates oxidative stress, and simultaneous change of useful energy into wasted energy or entropy. There is tremendous loss of resources reflected in corresponding reduction in enthalpy and increase in entropy during oxidative stress induced in quest for dominating over another system or group. Degradation of resources by spontaneous reactions such as those initiated by warring communities are rampant all over the world.

In addition to pushing the resources to impoverishment and the ever growing population to poverty, oxidative stress creates instability among the organized as well as unorganized groups. They lose several degrees of freedom and are shaken up by the root. Their unsettled status entails metastable state that is reflected in the humps in Figure 4. Being emotionally unsettled the affected population develops fugacious (escaping) tendencies and is induced to move on or migrate for its livelihood to urban centres. These centres are themselves plagued with high entropy (ΔS) and hence not prepared to absorb the migrants. The migration of population to the urban areas has amassed the urban clusters with social degradation and disorder by emergence of slums (semi solid state) around the cities. This situation of disorder in the organized areas of the cities has, while creating law and order problems in the sociologically compact areas, misbalanced the order-disorder equilibrium given by K_{eq} in equation (11-13) and shifted it to higher disorder.

SOCIO-PHYSICOCHEMICAL THEORY

Part-3 Socio-Physicochemical Theory on Terror & Terrorism

DOI: 10.13140/RG.2.1.1229.3523
Mirza Arshad Ali Beg
arshadalibeg@gmail.com
Research & Development Consultants
Karachi 75210, Pakistan

Abstract

Terror is interpreted in physicochemical terminology as an oxidant which has the potential to remove or decrease free energy from the reaction site, induce oxidative stress, create explosive situation, increase entropy or randomness, and completely shift the equilibrium to product side. Terrorism in Socio-Physicochemical terminology is the mechanism by which terror operates. In general it describes transfer/exchange of energy during spontaneous reactions of an oxidant with a target that may or may not be prepared for the shock.

The aftermath of terror is behavioural response to physical and emotional danger. Terror triggers stressful stimulus that is the natural tendency of the brain to inflate the perceived frequency or severity of an event that results in physiological symptoms such as tense muscles, rapid heartbeat and hysterical breathing. Stress, anxiety and fret are fueled by the distorted perception of events. The stressful situation inducing fight or flight response, or 'acute stress response', refers to psychological reaction that occurs when something that mentally and physically terrifies is around.

In response to acute stress, the body's sympathetic nervous system is activated by the sudden release of hormones. Sympathetic nervous systems stimulate the adrenal glands triggering the release of catecholamines, which include the hormones adrenaline and noradrenaline. Their release entails an increase in heart rate, blood pressure and breathing rate, and hence the level of concerned hormone can be used to measure the strain resulting from the stress.

In accord with Newton's 3rd Law of Motion, response to fear is facing ground reality. Accordingly the response to terror is not potentiated terror that entails exothermic/explosive reaction that may induce an explosive situation. Incidence of terrorism generally results in spontaneous decrease of internal energy $-\Delta H^{\circ}/RT$ (order) and increase in $\Delta S^{\circ}/R$ (disorder/entropy), both varying with the level of severity and spontaneity of interaction. Since terrorism is also defined as the organized use of randomly focused violence by organized groups against non-combatants to implement a political objective, its incidence is meant to i) shift the equilibrium and maximize the oxidative stress, ii) induce maximum depletion of ΔG the free energy, iii) decelerate the driving force of the system, and iv) put the status of compactness of the social system at stake. Like all explosive reactions terrorism induces the stress exponentially and produces extensive commotion besides depleting the resources in this fear driven world.

Acts of terrorism may induce maximum depletion of enthalpy, but according to the third law of Motion, terror may beget more terror since reaction to terrorism will be equally vehement. Hence the free energy minimum (at constant T and P) representing the most satisfactory compromise for sustainable living in a serene environment can be attained by maintaining the natural balance between enthalpy and entropy.

Repression of terror by use of force is expected to follow the Le Chatelier's Principle which has been adopted here as Socio-physicochemical Law of Equilibrium. The Law states: When a system at equilibrium is subjected to change in parameters like concentration, volume, pressure and temperature, the system readjusts itself to counteract (may be partially) the effect of the applied change and a new equilibrium is established. Application of the Law to terrorism suggests that on incidence of terror the terrorized will prepare and be in readiness for defense. This action will likely be due to the realization that terror will sooner or later beget terror and hence there will be an urgent need for readjustment. Restoration of equilibrium is generally sought by considering offence as the best defense. That however has been seen earlier to set a vicious circle in motion and instead of annihilating or even containing the impact of terrorism, it continues unabated.

Socio-Physicochemical Approach

Socio-Physicochemical principles suggest that generally physical and emotional factors are triggered by the events including extreme events e.g. fear, fright and terror. Socio-Physicochemical Theory holds that strain induced by stress results in physiological reactions such as tense muscles, rapid heartbeat and hysterical breathing. Stress and worry are fueled by the skewed perception of events. These inferences find strong support from the Two-factor Theory which holds that the aftermath of events is behavioural response that may give rise to organic symptoms (physical factors) as well as emotional (CNS related factors) symptoms. Events may trigger a mild or stressful stimulus; the natural tendency of the brain then inflates or deflates the perceived frequency or severity of event.

The aftermath of stress induced strain is behavioral reaction or response to physical and emotional danger. The behavioral and psychological symptoms that appear are indicators of the stress-strain relationship between stressor and the stressed (Physiological Responses to Terror, 23 APRIL 2011, Martha L. Hyde and http://marthalhyde.wordpress.com).

Definitions

Terror, meaning "to frighten, create fear, panic or horror", is an inflated form of fear which in itself is an unpleasant/negative emotion caused by the beliefs that someone or something dangerous that is likely to happen, may cause personal injury, or threat to life and property.
Terror is that aspect of physicochemical and physiological reaction/interaction in which there is spontaneous release of energy with simultaneous change of useful energy into entropy.
Terror extends over a wide range of human cruelties, including executions, guerilla attacks, ethnic cleansing and genocide (Charles Tilly. Terror, Terrorism, Terrorists. *Sociological Theory*, Vol. 22, No. 1, Theories of Terrorism: A Symposium (Mar., 2004), pp. 5-13).

Physicochemical Aspects of Terror

In physical terms terror constitutes application of physical force and follows Sir Isaac Newton's laws of motion:

- **Newton's First Law of Motion:** Unless acted upon by an outside force, a body at rest tends to remain at rest, and a body in motion tends to remain in motion.
- **Newton's Second Law of Motion:** An object changes velocity if it is pushed or pulled on. When an outside force acts on an object, the object's acceleration is directly proportional to the applied force and inversely proportional to the mass of the object. This law derives the formula of $F = ma$, where F is the force acting on an object, m is mass of the object, and a is the acceleration of the object.
- **Newton's Third Law of Motion:** For every action, there is an equal and opposite reaction.

Terror in physical terms constitutes use of physical force and follows as corollary of Newton's laws of motion:

- Following the first law, terror may be described as induction of physical force. A system will continue to perform its functions unless the inflated form of fear acts as an outside physical force and induces stress.
- Following the second law, a system will change its spontaneous character if it is subjected to push and pull forces. When terror is induced as an outside physical force, the response of and strain on the system is directly proportional to the applied force and inversely proportional to the magnitude of the system. This corollary is derived from the formula $F = ma$, where F is the force acting on a system, m is the magnitude of the system, and a is the system's spontaneity.

- Following the third law, for every action, there is an equal and opposite reaction, response to applied physical force, is an equal and opposite physical force. Thus terror may beget terror in one or the other form.

In chemical terms terror may be likened to incidence of exothermic reaction in a confined space. In exothermic reactions the internal energy of reacting species is greater than the internal energy of products. Such reactions are accompanied by increase in temperature which accelerates the rate of reaction exponentially; the heat so evolved dissipates randomly as waste of energy.

$$A + B \longrightarrow AB + (\text{Heat Waste}) \ldots\ldots\ldots (1)$$

Terror is interpreted in physicochemical terminology as an oxidant which has the potential to:

- Remove free energy from the reaction site
- Remove or decrease free energy
- Induce oxidative stress
- Create an explosive situation by depleting the microenvironment of free energy
- Increase entropy or randomness, and
- Completely shift the equilibrium to product side as in explosive reactions like in equations (1 & 2):

$$A + B \xrightarrow{\Delta F} \text{Stress } (\Delta S) \ldots\ldots\ldots\ldots \quad (2)$$

Here ΔF is the driving force of the reaction, and ΔS is wasted energy or entropy.

Behavioral Aspects of Terror

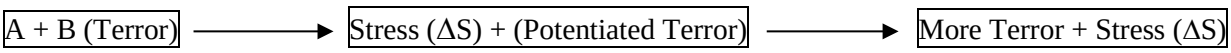
Fear and its escalated form Terror constitute an underlying driving force that generally moves or motivates actions and reactions in this fear-driven world. The role of fear as a driving force needs to be recognized mainly because it gets things done, often according to what needs to be done, for example:

- Threatening punishment to kids for misbehaving
- Threatening loss of job for the employee who does not perform
- Threatening fines and imprisonment for those who break the laws by government

The aftermath of terror is behavioural response to physical and emotional danger. Terror may trigger stressful stimulus that is the natural tendency of the brain to inflate the perceived frequency or severity of an event that results in physiological symptoms such as tense muscles, rapid heartbeat and hysterical breathing. Stress, anxiety and fret are fueled by the distorted perception of events. The stressful situation inducing fight or flight response, also known as ‘acute stress response’, refers to a psychological reaction that occurs in the presence of something that is terrifying, mentally and physically. The response is in terms of the ability to face the situation squarely by fighting or running away when perceiving danger.

In response to acute stress, the body's sympathetic nervous system is activated by the sudden release of hormones. Sympathetic nervous systems stimulate the adrenal glands triggering the release of catecholamines, which include the hormones adrenaline and noradrenaline. Their release entails an increase in heart rate, blood pressure and breathing rate. The body returns to its pre-arousal levels after recession of the stress, which takes from 20 to 60 minutes.

It is important to realize that terror begets more terror, and the more the life is focused on terror, the more terrorized becomes one's life, which develops into a never ending vicious cycle that does not annihilate. This apparently is in accord with Newton's 3rd Law of Motion: For every action, there is an equal and opposite reaction, response to applied physical force, is an equal and opposite physical force. The opposite of fear is ground reality. This suggests that the opposite of terror is not more terror because interaction of terror with potentiated terror may entail an exothermic reaction that may induce an explosive situation:



The stress situation referred to above is one in which a system at equilibrium has been subjected to change in concentration, volume, pressure and temperature. Most systems have the capacity to readjust, though partially and to counteract the effect of applied change and a new equilibrium is established. The new equilibrium may allow recovery and there are instances in history of rise and fall of Civilization where those subjugated have taken over the reigns of territories (Decline of Societies and Entropy Changes, Chapter VII, New Dimensions in Sociology, A Physicochemical Approach to Human Behaviour, Mirza Arshad Ali Beg, Hamdard Publications, Karachi, 1987). Terror has in most cases been countered with potentiated terror but has not been annihilated.

Terrorism

Terrorism is distinct from different forms of crime, while terrorists are different from criminals engaged in street crimes, robberies, arson and loot. Key characteristics of terrorism are related to:

- Largely political aims and motives
- Violence and threats of violence
- Designs to have far-reaching psychological impacts beyond the target or victim
- Organization with an identifiable chain of command or conspiratorial cell structure and a sub-national group or non-state entity (Bruce Hoffman, *Inside terrorism*,p-41, 2 ed., Columbia University Press, 2006).

Terrorism is defined as:

- Use of force (violence) to intimidate (induce stress & depression), to frighten randomly chosen targets for achieving limited objectives.
- Strategy adopted by interest groups that have a not-too-wide political base or by parties that are weak or inadequately equipped in asymmetric warfare.
- Course of action adopted by individuals, interest groups, and state actors who resort to terrorism in pursuit of political aim/gain or in the calculated use of violence or threat of violence against civilians, to attain goals that are political, religious or ideological in nature. This is done through intimidation, coercion or inciting fear.
- FBI defines terrorism as the unlawful use of force or violence against persons or property to intimidate or coerce a government or the civilian population, or any of its segments, to enhance political or social objectives or marketing forces.
- Use of negative forces to frighten randomly chosen targets. It is practiced by interest groups that have a restricted political base or by parties that are weak or inadequately equipped in asymmetric warfare; only limited objectives are achieved however.

The primary difference between terror and terrorism, according to David Forte is that while terror can be neutrally evil, as in random violence committed by robbers, rapists, and military personnel, terrorism has the additional political or moral dimension, that it constitutes use of violence by organized groups against non-combatants to force a political objective **(Forte, David F. (1986). "Terror and Terrorism: There Is a Difference". *Ohio Northern University Law Review*, Ohio Northern University Pettit College of Law, 13: 39–52).**

Terrorism in Socio-Physicochemical terminology is the mechanism by which terror operates in the environment. In general it describes the transfer/exchange of energy during spontaneous reactions of an oxidant with a target that may or may not be prepared for the shock.

Terrorism is likened in Physicochemical terminology to a free radical reaction. Free radicals are strong oxidants; they have the capacity to remove free energy from the reaction site, generally by chain reactions, and are often initiated by light. A number of free radical catalysts, the most important of which are the hydroxyl radical (OH·), nitric oxide radical (NO·), chlorine atom (Cl·) and bromine atom (Br·). They are denoted by a dot to indicate that all of these species have an unpaired electron and are thus extremely reactive. They are found in certain stable organic compounds, e.g. chlorofluorocarbons (CFCs), which may find their way to the stratosphere without being destroyed in the troposphere due to their low reactivity. Once in the stratosphere, the $Cl\cdot$ and $Br\cdot$ radicals are liberated from the parent compounds by the action of ultraviolet light, e.g.

$$CFCl_3 + \text{electromagnetic radiation} \rightarrow Cl\cdot + \cdot CFCl_2$$

Chlorine free radical reacts with an ozone molecule, taking an oxygen atom with it, forming ClO and leaving a normal oxygen molecule. The chlorine monoxide (i.e., the ClO) can react with a second molecule of ozone (i.e., O3) to yield another chlorine atom and two molecules of oxygen:

$$Cl\cdot + O_3 \rightarrow ClO + O_2$$

The chlorine atom changes an ozone molecule to ordinary oxygen:

$$ClO + O_3 \rightarrow Cl\cdot + 2\,O_2$$

The ClO from the previous reaction destroys a second ozone molecule and recreates the original chlorine atom, which can repeat the first reaction and thus an unending chain reaction continues to destroy ozone. The overall effect is a decrease in the amount and thinning of ozone layer that provides a shield against another strong oxidant viz. the ultraviolet radiation B. **(http://en.wikipedia.org/wiki/Ozone_depletion)**

Socio-Physicochemical Aspects of Terrorism

In Socio-Physicochemical terms, all interactions and processes, whether chemical, biological or social, involve transfer/exchange of energy for their completion and product formation. A reaction between A and B is said to be in equilibrium when the rate of forward reaction to form AB and backward reaction, or dissociation into A and B is in balance:

$$A + B \rightleftharpoons AB \qquad (3)$$

In equation (3) the forward process dominates over the reverse process only to the extent of forming just as many ABs as are dissociated into A and B. In general, however, the forward

reaction processes do not go to completion in the above simple and ideal form, and additional products such as those in equation (4) are found in the reaction mixture:

$$A + B \rightarrow AB + ABB + AAB + BA + ABA + BAB + \ldots\ldots \quad (4)$$

The formation of species viz. AB, BB, AA, BA etc. other than just AB is dissipation of useful energy into formation of by-products and waste products. This is described in energy terms as follows:

- ***Gibbs Energy (G)***

  $G = (U + PV) - TS$ ……(5)

  Here U is Internal Energy, PV is pressure x volume and TS is absolute temperature x final entropy

  (U+PV) in equation (5) can be defined as enthalpy: (U+PV) = H and Gibbs Energy related to enthalpy by equation: G = H − TS while the change in Gibbs energy is given by

  $\Delta G = \Delta H - T\Delta S$ …….. (6)

- Equation (6) is related to total entropy change of the universe in equation (7) and (8):

  $\Delta S_{universe} \cong \Delta S_{microenvironment} + \Delta S_{macroenvironment} + \Delta S_{global\ environment}$ … (7)

  $\Delta S_{universe} \cong \Delta S_{system} + \Delta S_{surroundings}$ …… (8)

  $\Delta S_{surroundings}$ can be rewritten as $\Delta H/T$; the heat, q_p, the system which affects the surroundings is the negative of the ΔH for the system. Because $-q_p = -\Delta H_{system}$, the change in entropy of the surroundings will be

  $\Delta S_{surroundings} \sim -\Delta H_{system}/T$.

  Equation (8) becomes:

  $\Delta S_{universe} \cong (\Delta H_{surrounding}/T) - \Delta S_{system}$ ……. (9)

  Multiplying both sides by T the equation becomes

  $T.\Delta S_{universe} \cong \Delta H_{surrounding} - T.\Delta S_{system}$ ……. (10)

- Since $\Delta G = \Delta H - T\Delta S$

  ΔG is indicative of changes in rate of reaction/spontaneity e.g.:

  $\Delta G < 0$ indicates a spontaneous* change to occur

  $\Delta G > 0$ indicates absence of spontaneity

  $\Delta G = 0$ indicates a system at equilibrium

The Gibbs Energy reaches the minimum value when equilibrium is reached. ΔG is the energy available to be converted to work. ΔH is the total energy that can be converted into potential energy, kinetic energy, electromagnetic radiation or phase changes. $T.\Delta S$ is the energy not available to be converted to work. Expressed in words:

(Total Free energy) = (Energy available for conversion) – (energy wasted/not available)

Thus ΔG is the energy free to do work, ΔH is enthalpy or internal energy available for conversion and ΔS is energy converted or not available or wasted.

- Helmholtz Energy is related to Gibbs Energy as follows:

  The Helmholtz Energy (A) is given by the equation:

  $A = U - TS$, which is comparable to Gibbs Energy:

$$G = A + PV \quad \text{…….. (11)}$$

The Helmholtz Energy is used when having a constant pressure is not feasible. Along with internal energy and enthalpy, the Helmholtz Energy and Gibbs Energy make up the quad group called the thermodynamic potentials; these potentials are useful for describing different thermodynamic events.

- Gibbs free energy ΔG, while combining enthalpy and entropy into a single value, predicts the direction of the chemical reaction under the conditions of constant temperature and constant pressure. If ΔG is positive i.e. $\Delta G > 0$, the reaction is non-spontaneous (requires external energy to induce interaction) and is not favoured. However, if it is negative i.e. $\Delta G < 0$, it is spontaneous (occurs without external energy input). The situation just stated can be described in terms of free energy as follows:

  $\Delta G < 0$ favoured reaction (Spontaneous)
  $\Delta G = 0$ forward and reverse reactions are in balance
  $\Delta G > 0$ unfavoured reaction (Non-spontaneous)

Any change in a system at equilibrium at constant temperature and pressure is such that the free energy remains constant. This then provides an answer to the question of how the drive towards maximum entropy and the drive towards minimum energy reach a compromise as a system strives towards equilibrium. *From the above equations it is evident that an increase in S and a decrease in H both tend to lower the free energy of the system*. Therefore the criterion for equilibrium would be to have T and P constant so that the free energy ΔG is a minimum. Similarly for Helmholtz free energy, the equilibrium condition at constant temperature and volume would be to have T and K constant so that the G is a minimum.

Energy of all types, the kinetic energy involved in phase changes of molecules; potential energy of molecules in fusion as well as vaporization, and electromagnetic radiation, is expected to disperse in universe while the energy remaining unutilized is considered as waste and converted to entropy. A specific quantity of molecular energy (social power in analogy), if dispersed in an interactive process, such as isothermal gas expansion/chemical reactions, constitutes entropy change given by ΔS. Entropy change in social interactions is, by analogy, a measure of how a specific amount of social cohesive power (molecular energy) is dispersed in an interactive process, such as those parallel to gas-liquid and solid mixing; reversible heating, phase changes, and chemical reactions.

Changes in Enthalpy during Spontaneous Reactions

Enthalpy is described as the thermodynamic potential of a system; it is used to estimate the useful work obtainable from a closed thermodynamic system under constant pressure and entropy. The equilibrium constant in equation (6) may be rewritten by combining the constants in Boyle's law, Charles's law, Avogadro's law, and Gay-Lussac's law as equation (12 or 13):

$$\Delta G = \Delta H - T\Delta S \quad \text{…….. (6)}$$

Equation (6) suggests that if $|\Delta H| >> |T\Delta S|$: the reaction is enthalpy-driven, and
if $\Delta H << T\Delta S$: the reaction is entropy-driven. There are two factors that affect the change in free energy ΔG:

ΔU = the change in internal energy, ΔS = the change in entropy of the system. The two factors provide an important criterion to determine whether or not a reaction is spontaneous.

$$-RT\ln K_{eq} = \Delta H^{o} - T.\ \Delta S^{o} \ldots\ldots\ \ldots\ldots\ (12)$$

$$\text{OR} \quad \ln K_{eq} = -\Delta H^{\circ}/RT + \Delta S^{\circ}/R \ldots\ldots\ldots\ldots\ (13)$$

Enthalpy has been seen earlier as related in equation: H = U+PV, hence equation (10)

$$T.\Delta S_{universe} \cong \Delta H_{surrounding} - T.\Delta S_{system} \quad \ldots\ldots\ldots\ldots\ (10)$$

Relating the change in entropy of the surroundings can be stated as:

$$T.\Delta S_{universe} \cong \Delta(U + PV)_{surrounding} - T.\Delta S_{system} \ldots\ldots\ (14)$$

Equation (12 & 13) appraised in the light of (14) suggests that the intensity of spontaneity of reaction given by K_{eq} depends on the balance between ($\Delta S^{\circ}/R$) and $\{-\Delta(U + PV)_{surrounding}/RT\}$. The balance between enthalpy and entropy will be disturbed on alteration of reaction condition, for example increasing pressure which will tend to reduce the volume, and rise in temperature will increase the volume, while all such changes will change the rate of reaction, intensity of spontaneity and state of aggregation. External energy input will in each case of alteration:

1) induce oxidative stress whereby ΔG the free energy will be depleted and thus the driving force will be restrained so as to slow down the reaction,
2) result in lowering the ΔH and increasing the ΔS, implying that the internal energy will yield to higher values of entropy,
3) adjust the intramolecular forces to sustain the molecular framework,
4) change the orderly into a disordered state, and
5) put the status of compactness of the structure at stake.

In the socio-physicochemical perspective, internal energy is considered analogous to resources, which will, under equilibrium conditions given by equation (13 & 14) remain constant for a community settled in an isolated place unless converted into another material form or wasted. A communal system under such conditions with $\Delta G = 0$ has no tendency to modify or transform its resources since its tendency for forward reactions is in balance with the desire to reverse the reaction. The community will lose energy in cases where $\Delta G < 0$ and the reaction induced by interaction with terror/social oxidant in the surroundings is spontaneous. The system will gain energy when $\Delta G > 0$ is the unfavoured reaction, which is non-spontaneous. Stress is removed in such systems by obtaining relief / input of free energy from outside. In dealing with another system the social oxidant in the form of fear or terror that is its escalated form, will use up the internal energy or resources in the surrounding.

The value of K_{eq}, the equilibrium constant, representing *intensity of spontaneity* of communal interaction in socio-physicochemical terms will increase in equation (12) with: a) an increase in ΔS° (negative quantity), and b) decrease in ΔH° (positive quantity). This implies that the balance will be shifted to higher entropy values or randomness on increase in ΔS° ($\Delta S^{\circ}/R$) of the commune and decrease in ΔH° ($-\Delta H^{\circ}/RT$), the internal energy or resources of the system, thus instigation or intimidation of any sort will increase the entropy and create disorder or randomness in the total system. Increase in ΔS° leads to decrease in the degrees of freedom in the system, since it lowers the internal energy of the reactant species or the intra-species forces in the communal system, leading to increase in openness and decrease in compactness cohesive character of the social system.

Changes in Equilibrium during Terrorism Induced Spontaneous Reactions

K_{eq}, the equilibrium constant, may be considered as a measure of intensity by which free energy is depleted from the system. The balance between $-\Delta H^{\circ}/RT$ (enthalpy) and $\Delta S^{\circ}/R$ (entropy), or between order and disorder, in the same system under any given set of conditions, remains difficult to achieve because the equilibrium is generally shifted to entropy which always tends to be maximum and the enthalpy has its limitations. Enthalpy may be minimized but not reduced to zero, or else it would be catastrophic.

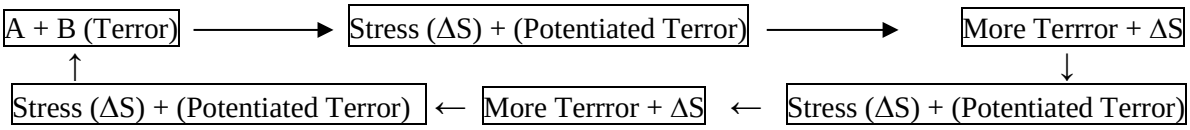
Incidence of terrorism generally results in spontaneous decrease of internal energy $-\Delta H^{\circ}/RT$ (order) and increase in $\Delta S^{\circ}/R$ (disorder/entropy), both varying with the level of severity and spontaneity of interaction. Since terrorism has been defined earlier as the systematized use of randomly focused violence by organized groups against non-combatants to implement a political objective, its incidence is meant to i) shift the equilibrium and maximize the oxidative stress, ii) induce maximum depletion of ΔG the free energy, iii) decelerate the driving force of the system, and iv) put the status of compactness of the social system at stake. Like all explosive reactions terrorism induces the stress exponentially and produces extensive commotion besides depleting the resources in this fear driven world.

Acts of terrorism may induce maximum depletion of enthalpy as in equation (6), but according to the third law of Motion, terror may beget more terror since reaction to terrorism will be equally vehement. Hence the free energy minimum (at constant T and P) representing the most satisfactory compromise for sustainable living in a serene environment can be attained by maintaining the natural balance between enthalpy and entropy.

The natural balance between enthalpy given by $\{-\Delta(U + PV)_{surrounding}/RT\}$and entropy given by $(\Delta S^{\circ}/R)$ can be obtained by optimizing temperature and pressure. Increase in either parameter beyond the optimum increases the level of severity and chances of spontaneity of the reaction. In socio-physicochemical perspective, excessive use of force will create stress and strain and escalate the fear into terror. Since terror begets more terror use of excessive force will set a vicious circle in motion; war on terror may follow, which may lead to race for superiority over inferiority, and richness over poverty. The balance between enthalpy (resources) and entropy (wastes) will remain disturbed, more resources will be fixed and will, like wastes, not be available. A win-win situation will be difficult to attain, while the ensuing disorder will increase instead of being reversed.

Le Chatelier Principle or Socio-physicochemical Law of Equilibrium

Repression of terror by use of force is expected to follow the Le Chatelier's Principle which has been adopted here as Socio-physicochemical Law of Equilibrium. The Law states: When a system at equilibrium is subjected to change in parameters like concentration, volume, pressure and temperature, the system readjusts itself to counteract (may be partially) the effect of the applied change and a new equilibrium is established. Application of the Law to terrorism suggests that on incidence of terror the terrorized will prepare and be in readiness for defense. This action will likely be due to the realization that terror will sooner or later beget terror and hence there will be an urgent need for readjustment. Restoration of equilibrium is generally sought by considering offence as the best defense. That however has been seen earlier to set a vicious circle in motion and instead of annihilating or even containing the impact of terrorism, it continues unabated. This is generalized by the equation:



A typical example of the unabated motion of the vicious circle is to be found in the free radical attack on the ozone layer in the stratosphere. The current war on terror presents another example which will be discussed in a subsequent section. In both cases the chemical oxidant from CFCs or social oxidant in the form of terror, will use up the internal energy and resources in the surrounding.

SOCIO-PHYSICOCHEMICAL THEORY

Part 4: Entropy of Resource Impoverishment & Wealth Accumulation

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Mirza Arshad Ali Beg
arshadalibeg@gmail.com
Research & Development Consultants
Karachi 75210, Pakistan

Abstract

Development processes aiming to improve the quality of life and inculcate superiority complex, invariably consume the internal resources and cause their irreversible depletion in the ecosystem. Since $\Delta H << T\Delta S$, all activities requiring external energy input are entropy-driven. Development activities being exploitative in character will use up available resources, irreversibly transform them (internal energy ΔH) into another form and increase the entropy; they reduce the ΔG, the driving force of the system and push the (Earth's) resources to impoverishment and the unprivileged stakeholders to the poverty line. They additionally induce impoverishment of resources, and alter the order and quality of socio-physicochemical structures. Accordingly the exploiting community skims out as the main beneficiary and emerges as the top of the status pyramid.

Affluence and poverty have assumed new dimensions in that the rich with its entrepreneurial and manipulative skill is in a better position to transform the resources into available and unavailable forms, separating itself out in the meanwhile from the impoverished environment. The vehicle for shifting from poverty to richness is entropy driven. Lack of technical competence has retained poverty in areas that have been impoverished by irreversible exploitation of resources. The rich with its entrepreneurial skill continues to enjoy the benefit by transforming the exploited resources into cash for relishing the richness.

Technology has the potential to induce oxidative stress. As such development of the capacity to apply technology sets the driving force ΔG and uses the internal energy ΔH; there is accompanying increase in entropy in the meantime. The lust to avail higher capacity to apply technology and become rich is entropy driven. Going by Forbes data for 2015, it is noted that the race of the rich to become richer has entailed rapid increase of entropy, which in turn has resulted in uneven class structure.

Enormity of the entropy driven race to richness seems set to widen the gap between poverty and affluence on the one hand and impoverishment and resourcefulness on the other hand. The race if not arrested is likely to entail much rapid increase of entropy of the universe. The number of hungry people currently (2015) stands at about 805 million in the world, i.e. one in nine suffers from hunger. Almost 1.5 billion people are "multi-dimensionally poor, with overlapping deprivations in health, education and living standards." Another 800 million people are living on the edge of poverty "vulnerable to falling back into poverty when setbacks occur."

Irreversible Conversion of Resources (H) into Wealth (S)

Rapid increase in number of ultrahigh net worth individuals (UHNWI) is in total contrast with persistent poverty and slavery. Analysis shows that Global wealth increased to a high of $241 trillion, which implies a 68 percent enhancement over the past 10 years. The Global private wealth reached $263 trillion. The average wealth per adult also reached the highest level of $51,600. Switzerland, Australia and Norway top the list of average wealth per adult totaling $513,000, $403,000 and $380,000 respectively (http://www.cnbc.com/id/101105809#). Increase in number of billionaires implies use of technology to irreversibly convert $7.3 trillion worth of resources into wealth and accumulation of $263 trillion worth of Global Wealth suggests depletion of resources ($-\Delta H$) and corresponding increase in their unavailable forms of energy and materials (ΔS).

The industrialized world, in enjoying its richness and resourcefulness, consumes two to three times as much on food, energy and other goods and services as it did 60 years back. The price of increase in consumerism is paid by those who have been left out in the developing and least developed countries and that is done through over-exploitation/ degradation of their land, rivers, air, forests, and oceans. The emerging economies have in their turn followed the industrialized countries and have adopted the fastest rate of growth for depletion of their resources.

In summary the resources of the Earth have been transformed into wealth (richness/affluence) and arms or in the capacity to wage wars (not necessarily win wars) at varying rate over the past six decades. Affluence and poverty have been given new dimensions by the increasing use of technology to transform the world resources irreversibly and fix them into wealth that is characterized here as unavailable form of material and energy (entropy). In the light of equations (1 - 5) the development processes involving

transformation of resources into wealth are no more than oxidative stress. They increase the entropy of the Earth and concentrate the wealth into the top 1% population. The income gap between the high up as well as the middle and lower strata remains substantially large since the benefit of resource utilization is not shared with the less advantaged people.

Introduction

Earlier studies (1,2,3,4) and the papers: Socio-Physicochemical Theory Parts 1-3 describe the consideration of External Energy input as an oxidant. As such Gibbs energy (G) induces oxidative stress, depletes internal energy (ΔH), and raises the entropy (ΔS) of the system during the processes aiming at development for improving the quality of life thereby inculcating superiority complex. Such processes invariably consume the internal resources to cause their irreversible depletion in the ecosystem. Since $\Delta H << T\Delta S$, all activities requiring external energy input will be entropy-driven. Considering the limitations of resource availability of the Earth, development processes are expected to be entropy driven since in expressing order out of disorder they will only raise the entropy of the system:

$$\Delta S_{total} = \Delta S_{surrounding} + \Delta S_{system} \rightarrow \{S_{universe} \sim \Delta S_{disordered} - \Delta S_{ordered}\}$$

Development activities being exploitative in character will, in using up the available resources, irreversibly transform the resources (internal energy ΔH) into another form and increase the entropy; it will additionally reduce the ΔG, the driving force of the system. An example in this regard is provided by extensive excavation of sand from the river bed anywhere, but Nethravathi river in India is of recent occurrence. The process has hit around 60 families living in Uliyakudru Island near Adyar, 10km from Mangalore in South India. Around 250-truck load of sand is being legally transported to Urban Bangalore daily on a government directive to meet the requirements of the rapidly growing construction industry set up there. (http://timesofindia.indiatimes.com/city/mangalore/Adopt-uniform-sand-mining-policy-for-coast-Minister/articleshow/43968425.cms).

Exploitation of the limited resources of the Earth has, in the context of equations:

$$S_{universe} = \Delta S_{solution/suspension} - \Delta S_{crystals/solids} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\Delta S_{system} = \Delta S_{solution} - \Delta S_{solid} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$S_{universe} = \Delta S_{macroenvironment} - \Delta S_{built\ environment} \quad \ldots\ldots\ldots\ldots (3),$$

irreversibly altered and in some cases, Nethravati river bed for instance, degraded the quality of the ecosystem besides depleting the potential of its key elements viz. water, soil, and vegetation that serve as the natural foundation for human existence. The fragility of ecosystem of the vulnerable regions will be subject to degradation and alteration in the Order – Disorder equilibrium such as in above equations. In all such cases, K_{eq} which represents the balance between ($\Delta S^{\circ}/R$) and ($-\Delta H^{\circ}/RT$), will be altered by agents of change (ΔG) that have the potential to induce oxidative stress and alter the orderly into a disordered system (ΔS) irreversibly.

Considering a broader perspective, it is observed that in the Middle East, which was part of the Ottoman Empire until 1924, the breakup into small units reduced their resources to subsistence level. Exports of commodities other than petroleum products from the entire Middle East with its 400 million populations now only equal that of Switzerland. The resources have all been impoverished to economic stagnation, which according to David Fromkin "A Peace to End All Peace, The Fall of the Ottoman Empire and the Creation of the Modern Middle East (1989)" was largely (entropy driven) due to domination of forces (external energy) that disrupted the trade networks and created new nation states. The breakup of the Soviet Union into the Alliance of States presents case examples relevant to inducing oxidative stress and alteration of orderly into a completely disordered system following the above equations.

Such processes of irreversible transformation of internal energy (resources) into another form are converting the resources into irreversible forms. Thus, while raising the content of unavailable energy (entropy ΔS**)** and decreasing the enthalpy ΔH, they are pushing the (Earth's) resources to impoverishment and the unprivileged stakeholders to the poverty line. The resources having been impoverished, the stakeholders have to shift for their livelihood to urban centres, which are themselves plagued with high entropy (ΔS) and hence not prepared to absorb the migrants. The process of urbanization depicted by equation: $S_{universe} = \Delta S_{macroenvironment} - \Delta S_{built\ environment}$ … (3), is itself entropy driven, and hence

migration of population to the urban areas amasses the urban clusters with degradative forces including socio-physicochemical disorder by increasing slums (semi solid state) around the cities. This situation of disorder in the organized areas of the cities has misbalanced the order-disorder equilibrium given by K_{eq} which represents the balance between ($\Delta S^{\circ}/R$) and ($-\Delta H^{\circ}/RT$) and made them vulnerable to change of higher disorder.

Exploitative situations such as the above while inducing impoverishment of resources, have entailed alteration in the order and quality of socio-physicochemical structures. Accordingly the exploiting community has skimmed out as the main beneficiary and emerged as the top of the status pyramid. The facilitators, service providers and other stakeholders are placed in the lower down strata. The top gets richer with increasing transformation of resources (ΔH) into (unavailable forms ΔS) while the rest in the social structure faces the stress of deprivation created by impoverishment (equation 1-3). The vicious circle of resource impoverishment completes partially when the exploiters get command of the situation and completely exhaust the resources, while those feeling deprived either move out, since there is nothing for them to depend on, or precipitate out as Agents of Change to upgrade their status if not reverse the disorder.

Operation of the circle of resource impoverishment is apparent in the processes that induce oxidative stress by removing vegetation (oxidizing the organic material, and releasing carbon dioxide and water vapour into the air) that has survived in the largely arid areas. Shortage of liquid and gaseous fuel has created un-estimated urban demand for firewood, and created opportunity for the landowners to cash the resource (property and firewood). Landowners in such resource deficient areas yield to the urban demand for land and firewood. They engage their captive labour force for removing trees, in most cases even by the root, and supplying it to the charcoal kilns owned by them. Hundreds of charcoal kilns have been established just to fulfill the urban and industrial demand for a certain form of energy. Exploitation of the thin forest resources follows the scheme stated by equation (4):

$$S_{universe} \sim \Delta S_{macroenvironment\ (rural\ area)} - \Delta S_{urban\ demand} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

This equation suggests that the entropy driven process of impoverishment uses up the resources of the rural area for short term gain by the landowners and urbanites. The process however irreversibly depletes the resources (ΔH) and pushes the low level farm workers, herders and wood cutters to the poverty line. The depletion of resources is compounded by frequent droughts, floods and loss of land due to faulty irrigation/agricultural practices besides erosive actions of the sea in the coastal area. The trend, of uprooting shrubs, cutting trees for fuel wood, over grazing due to over stocking, and sand /gravel removal from the river beds, is stretching from the plains to the interior and towards the hills and mountains. If the current trend continues, the already exhausted rangelands will not be in a position to support the existing level of livestock population of the arid region. The economic impact of such a situation has had direct impact on the population which subsists on the scant resources that are not its own. The increase in depletion of resources is likely to continue with all the vagaries of the ecosystem and so may the level of poverty amongst the dependent population.

Generation after generation has been witness to skimming of the resources by the exploiter and leaving the impoverished system for the rest to bear with subsistence living. Likewise the poor nations have not been able to improve the lot of their poor and on an overall basis they have continued to remain poor. The entrepreneurial class in the developing and developed countries has on the other hand used its skills and applied technology to raise its status; it is thus able to enjoy the affluence. The industrially advanced countries have gone a step further and after exploiting the resources of their own and of the countries that they had subdued, attained superiority in trade and weapons. They are engaged in maintaining and attaining better status thereby using up resources on global scale. The vicious circle of resource impoverishment continues with no end in sight.

Affluence and poverty have assumed new dimensions in that the rich with its entrepreneurial and manipulative skill is in a better position to transform the resources into available and unavailable forms, separating itself out in the meanwhile from the impoverished environment, as suggested by equations (1-3 & 4). The vehicle for shifting from poverty to richness is entropy driven. It needs technical competence to exploit the resources at a rapid rate as suggested for spontaneous reactions with $\Delta G < 0$ but high values of entropy, $T.\Delta S$. Lack of technical competence has retained poverty in areas that are impoverished or have been impoverished by irreversible exploitation of resources. The rich with its entrepreneurial skill continues to enjoy the benefit by transforming the exploited resources into cash for relishing the richness.

Technology has the potential to induce oxidative stress. As such development of the capacity to apply technology is to set the driving force ΔG in motion and use the internal energy ΔH and decrease it, and increase the entropy in the mean time. The driving force infused by technology has i) helped the forward reaction to yield high dividends, ii) made the rich upper stratum of the society richer, iii) depleted the resources to the limits of exhaustion, and iv) increased the entropy of the Earth in the meantime, as suggested by equation (5):

$$\Delta S_{universe} = \Delta H_{surrounding} - \Delta S_{Technology\ promoted\ system} \quad \text{..... (5)}$$

The lust to avail higher capacity to apply technology and become rich is entropy driven. Equation (5) has just shown that the driving force infused by technology has helped the forward reaction to yield high dividends, thereby making the rich upper stratum of the society richer. Going by Forbes data for 2015, the following lines illustrate that the race of the rich to become richer has entailed rapid increase of entropy, which in turn has resulted in uneven class structure:

- Just one percent of the population owns $110 trillion, which is 65 times the total wealth of the bottom half of the world population.
- The richest 85 persons own as much as is owned by the bottom half of world population.
- The lower half of global population possesses only 1% of global wealth, while the richest 10% adults own 86% of all wealth, and the top 1% account for 46% of the total.
- Seventy percent population lives in countries where economic inequality has increased during the last 30 years.
- The wealthiest one percent in USA captured 95 percent of post-financial crisis growth since 2009, while the bottom 90 percent became poorer.
- The global Ultra High Networth (UHNW) population grew by 0.6 percent to 187,380 with a combined wealth of $25.8 trillion.
- The combined wealth attributable to this segment shrank by 1.8 percent from 2008 due to Euro Zone Crisis and slowdown in emerging economies *(http://economictimes.indiatimes.com/topic/Euro-zone-crisis)*.
- Asia saw 2.1 percent reduction in UHNW population amongst the regions owing to poor equity performance, particularly in Japan, China and India.
- In India, the lowest tier of the UHNW group represented by those worth $30 million to $49 million is the largest group, making up 45.7 per cent of the total UHNW population. They have a combined fortune of $125 billion, or 13.5 per cent, of the total wealth of the ultra affluent in India.
- Forbes reports that the number of billionaires increased from 691 in 2005, to 946 in 2007 and to 2325 in 2014 while the aggregate wealth of these persons increased from $2.2 trillion, to $3.5 trillion in 2007 and stands at $7.3 trillion in 2014.

Growth promoted by technology was estimated in 2015 to create another large number of billionaires in the coming years; currently, less than 4 per cent of the ultra-rich in the world have made their wealth in this sector. In a conservative scenario, the global billionaire population will rise to around 3,600 billionaires by 2020, a net increase of 56 per cent, while in the most bullish scenario, there would be over 4,100 billionaires by 2020, an increase of 78 per cent on their current levels.

According to Global Wealth Report 2014 the rich became richer the world over during 2013, while the Global private wealth rose by $20.1 trillion (or 8.3%) in 2013 to reach $263 trillion. This is the largest increment in global wealth which is 20% above the pre-crisis level and 39% above that of 2008.

The wealth gap increased in the rapidly growing economy of India; in 2000, the richest 10% owned 65.9% of the total wealth in India, while in 2014, the ownership increased to 74%, indicating a greater concentration at the top of the pyramid. The report shows that 94.5% of Indian adults have less than $10,000. In China, the gap is not so stark, with 62.3% of adults having less than $10,000 and 35.4% having between $10,000 and $100,000. On the whole, the global average wealth is $56,000.

The size of the global Middle Class is likely to increase during the next five years i.e. by 2019. While the number of adults with wealth below $10,000 may shrink by 1%, the middle class (net worth between $10,000 and $100,000) will expand by 30%. The upper-middle class (net worth between $100,000 and $1 million will grow by 22%. Of the additional 401 million adults in the middle segment (2019), 75% are projected to be from Asia-Pacific (including China and India) and 45% of them are likely to be from China alone.

The enormity of the entropy driven race to richness seems set to widen the gap between poverty and affluence on the one hand and impoverishment and resourcefulness on the other hand. The race if not arrested is likely to entail much rapid increase of entropy of the universe.

IN TOTAL CONTRAST

The number of hungry people currently (2015) stands at about 805 million in the world, i.e. one in nine suffers from hunger. According to The Report jointly prepared by FAO, the International Fund for Agricultural Development and the World Food Programme, the number has declined by more than 200 million since 1990-92. Asia, the most populous continent, has 526 million hungry people, which includes India with 190.7 million, Pakistan 39.6 million, Bangladesh 26.2 million, Sri Lanka 5.2 million and Nepal 3.6 million.
http://economictimes.indiatimes.com/articleshow/42819495.cms?intenttarget=no&utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

The contrast is easily discernible in India where affluence and poverty, and for that matter order and disorder are growing together, with affluence growing rapidly and poverty reducing but slowly. The high economic growth is centrifuging millionaires by the thousands (it added in 2010 as many as 26,300 HNWIs) out of mass poverty. This may be the reason for India being ranked 138th on the basis of per capita income by the IMF and 119th in the UN Human Development rankings based on indicators such as life expectancy and education.

United Nations Development Report: "Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience, July 24, 2014 says:

- Almost 1.5 billion people are "multi-dimensionally poor, with overlapping deprivations in health, education and living standards."
- Another 800 million people are living on the edge of poverty "vulnerable to falling back into poverty when setbacks occur."
- The largest concentration of absolute poverty is in South Asia, with "more than 800 million poor and over 270 million near-poor—that is, more than 71 percent of its population."
- Income inequality in the developing countries rose by 11 percent between 1990 and 2010.
- The steepest decline in living conditions during 2013 occurred in Central African Republic, Libya and Syria, three countries targeted by US and French imperialism for military intervention and political subversion.

- About 45 million people were forcibly displaced due to conflict or persecution by the end of 2012, the highest in 18 years, more than 15 million of them refugees.
- Indigenous peoples make up about 5 percent of the world's population, but account for 15 percent of the world's poor, with as many as a third in extreme rural poverty.
- Nearly half of all elderly people, 46 percent of those aged 60 or older, suffer from one or more physical or intellectual disability.
- Children in the developing countries: "7 in 100 will not survive beyond 5; 50 will not have their birth registered, 68 will not receive early childhood education, 17 will never enroll in primary school, 30 will be stunted and 25 will live in poverty."

Slavery Index

This Index estimates that there are 29.8 million people in modern slavery globally. When considered as a percentage of population, the prevalence of modern slavery is highest in Mauritania, Haiti, Pakistan, India, Nepal, Moldova, Benin, Cote d'Ivoire, the Gambia and Gabon. However, when considered in absolute terms, the countries with the highest estimated numbers of enslaved are India, China, Pakistan, Nigeria, Ethiopia, Russia, Thailand, Democratic Republic of Congo, Myanmar and Bangladesh. Taken together, these ten countries account for more than 76% of the total estimate of 29.8 million enslaved. The top 10 countries ranked for their low prevalence are: Ireland, Iceland, UK, New Zealand, Switzerland, Sweden, Norway, Luxembourg, and Denmark.

Irreversible Conversion of Resources (H) into Wealth (S)

The above mentioned rapid increase in number of ultrahigh net worth individuals (UHNWI) is in total contrast with persistent poverty and slavery. The analysis shows that Global wealth increased to a high of $241 trillion, which implies a 68 percent enhancement over the past 10 years. The Global Wealth Report 2014 shows that the Global private wealth reached $263 trillion. This is the largest increment in global wealth which is 20% above the pre-crisis level and 39% above that of 2008. According to the annual Global Wealth Report by Credit Suisse the average wealth per adult has also reached the highest level of $51,600. Switzerland, Australia and Norway top the list of average wealth per adult totaling $513,000, $403,000 and $380,000 respectively (http://www.cnbc.com/id/101105809#.).

The above noted increase in number of billionaires should be viewed as enhancement in capacity of Agents of Change to use technology and irreversibly convert $7.3 trillion worth of resources into wealth. The conversion of $7.3 trillion worth of resources by the billionaires and accumulation of $263 trillion worth of Global Wealth should be considered in terms of equation (1-5) as depletion of resources ($-\Delta H$) and corresponding increase in their unavailable forms of energy and materials (ΔS).

With the beginning of the 1970s, economic growth slowed so the wealthy concentrated on consolidating their gains, ignoring the wide gap between affluence and poverty. Resources (ΔH) were increasingly transformed into arms and wealth (ΔS) and the income gap (order-disorder equilibrium) was widened correspondingly. Income growth for households in the middle and lower parts of income distribution system slowed sharply. Wealth, the value of property of a household, and financial assets, minus the value of its debts, is now more concentrated than income. The data available show a dramatic increase in wealth concentration at the top, the percentage of wealth held by the wealthiest has risen sharply over the last three decades.

The Report of the business magazine *Forbes*, ranking 400 wealthiest Americans, revealed that since 2009, the 400 richest Americans have nearly doubled their net worth to $2.9 trillion. This is nearly a fifth of the total value of all the goods and services produced in the United States in an entire year. (www.wsws.org/en/articles/2014/10/08/pers-o08.html) Since 2010, the median household income in the US has fallen by five percent.

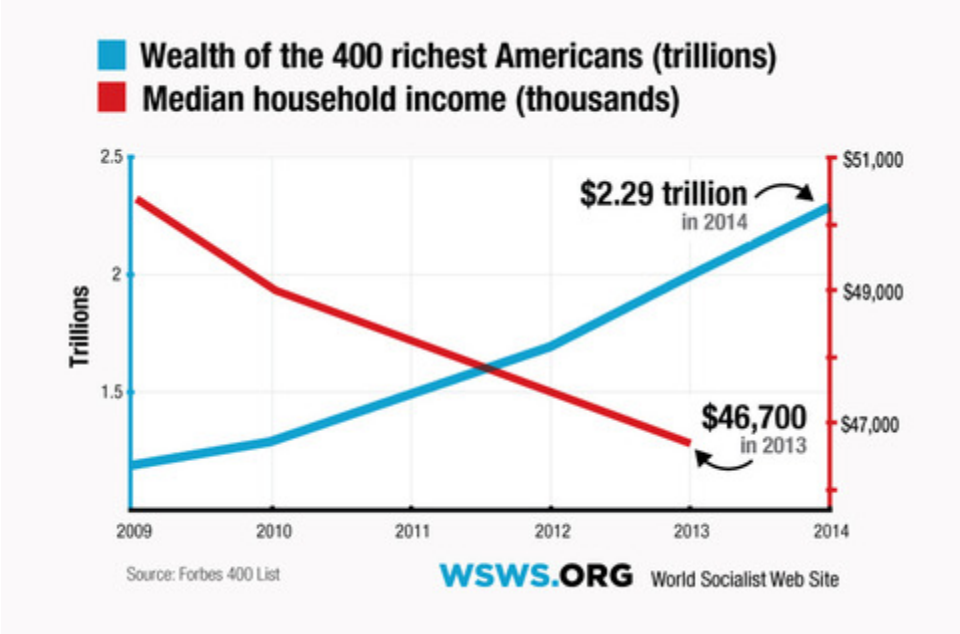

Figure 1: Wealth of the Richest

It is estimated that Global resource conversion into wealth may increase by 40 percent during the next five years to reach $334 trillion by 2018. The rate of conversion of resources into wealth in the emerging markets is likely to exceed that of the developed world. Following equation (5), it is possible to say that technology is being applied at a fast rate to convert the available resources into wealth and armaments. Accumulation of wealth by application of technology by the G8 and Western Industrialized countries, along with several Asian and OPEC Nations, and irreversible transformation of $263 trillion worth (2014) and estimated $334 trillion worth (2018) of resources into unavailable forms of material and energy has been interpreted as impoverishment of resources by the same value, their fixation into unavailable forms and dispersion finally as $\Delta S_{universe}$.

The industrialized world, in enjoying its richness and resourcefulness, consumes two to three times as much in terms of food, energy and other goods and services as it did without much application of technology 60 years back. An average child in the industrialized country consumes and pollutes more than what 30 to 50 children do in the third world countries. The richest fifth of the world population uses 58% of the total energy, produces 53% of the carbon dioxide emissions and owns 87% of the world vehicles, while the poorest fifth of the world population consumes 3% of the total energy, causes 4% of total emissions, and owns less than 1% of all the cars. The world resources and environment have thus been put under tremendous stress of consumerism. The vicious circle of consumption has been set into motion instead of the virtuous circle for conservation of resources. The price of increase in consumerism is paid by those who have been left out in the developing and least developed countries and that is done through over-exploitation/ degradation of their land, rivers, air, forests, and oceans. The emerging economies have in their turn followed the industrialized countries and have adopted the fastest rate of growth for depletion of their resources.

In summary the resources of the Earth have been transformed into wealth (richness/affluence) and arms or in the capacity to wage wars (not necessarily win wars) at varying rate over the past six decades. Affluence and poverty have been given new dimensions by the increasing use of technology to transform the world resources irreversibly and fix them into wealth that is characterized here as unavailable form of material and energy (entropy). In the light of equations (1 - 5) the development processes involving transformation of resources into wealth are no more than oxidative stress. They increase the entropy of

the Earth and concentrate the wealth into the top 1% population. The income gap between the high up as well as the middle and lower strata remains substantially large since the benefit of resource utilization is not shared with the less advantaged people.

SOCIO-PHYSICOCHEMICAL THEORY

Part 5: Assessment of Stresses of Social Pollution & Kleptocracy

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Mirza Arshad Ali Beg
arshadalibeg@gmail.com
Research & Development Consultants
Karachi 75210, Pakistan

Abstract

Stressors are defined in terms of Socio-Physicochemical theory as entities that skim out useful product from entropy-driven development processes. The skimming process when translated into equations (1 - 6) implies that while inducing consolidation of structures e.g. systems emerging from surroundings; solutions yielding solids/crystals; order carving out of disorder; built environment emerging out of disordered system in parallel with the process of crystallization out of a solution, there is an overall impoverishment of resources, suggested by increase in entropy of the systems. Development processes, while depleting the resources (ΔH) of the system, fix them into irreversible/unavailable forms such as structures and wealth, thus contributing to overall increase in entropy of the universe.

Industrially advanced countries have skimmed out steadily as well as rapidly into socially coherent, economically stable and technologically advanced states, from the rest of the world comprising the unorganized and semi-organized systems. It is natural for elitist societies that have carved out affluence from impoverishment while achieving prosperity, to conserve the potential and maintain their ordered / organized status and higher values, by keeping the poverty ≈ affluence and order ≈ disorder equilibrium given by K_{eq} in equation (9) in favour of organized state.

Social pollution as a socio-physicochemical singularity describes an entropy driven social system in terms of distress created by deeds and misdeeds of the social unit. Codes considering actions and reactions as acts of Social Pollution are described. Application of the codes to processes of social pollution indicates that societies, which employ entropy-driven techniques and high specific reaction rates for up-gradation of quality of life and enhancement in quality of environment follow the order-disorder equation to carve out order from disorder. They transform the resources of the Earth into wealth/richness/affluence at varying rate, and in doing so set new lows for impoverishment and greater heights for affluence. The end result is increase in entropy of the universe.

Forward reaction that transforms and fixes ΔH into product in an ordered state may be reversed by negative forces, for example by acts of terrorism that create chaos and disorder.

$$S_{univ} \sim \Delta S_{disordered} - \Delta S_{ordered}$$

This suggests that ***order and disorder can co-exist if the severity of driving force of the respective systems is neither domineering nor subjugative but in balance. The balance needs to be keenly managed so as not to allow entropy to dominate over enthalpy, or else there will be catastrophic end.***

Development Processes need to be economically viable, socially acceptable and environmentally bearable, in order to meet the Sustainability criteria. Newly industrialized countries have resorted to fast track industrialization characterized by rates of spontaneous reactions that have $\Delta G < 0$ and high entropy. The

process of status up-gradation passed through {conversion of resources (ΔH)} → (energy/material form) → (harvesting) + (accumulation of wealth)} and in not following the sustainability criteria committed acts of social pollution of varying degrees.

Corruption Perception Index, CPI, developed by Transparency International (TI) has been adopted in the present studies on Socio-Physicochemical Theory as a pointer of Social Pollution Level (SPL). Analysis of CPI scores shows that Principles of Sustainability are violated while a balance arrived at in equation (3 & 4) is not maintaned:

$$S_{universe} \sim \Delta S_{disordered} - \Delta S_{ordered} \approx \Delta S_{Impoverishment} - \Delta S_{affluence} .$$

The group of countries with CPI score ranging from 4.0 to 8.5 is composed of entities with and without cohesive forces among them. Their governments may split into formal and informal; democratic and pseudo democratic, and autocratic and kleptocratic systems of governance. This may lead to formation of parallel governments and degrade the formal system. Individuals improve their status by intensifying the driving force for conversion of resources into wealth. This has led to substantial increase in the number of millionaires and billionaires, in the number of rich and super rich, and in the conversion of several trillion dollar worth of resources into wealth and arms. This has been achieved not by pooling up the resources or sharing the richness in resources and technology globally, but by giving strength to the long handle of social pollution to globalize corruption.

CPI analysis shows that countries with medium level CPI (6.0 – 8.5) have been working for ***democratizing capitalism*** **and** ***mixing-in militarism***. With large size of their economy, they have been able to harness the driving force for enjoying-the-richness psyche, and to ***mix-in militarism*** for achieving supremacy in trade and weaponry. There is no serious commitment from them for changing their psyche to the sustainable process of sharing-the-resources in an attempt to break the vicious circle, which is responsible for inducing corruption/social pollution, and disfavouring virtuous circle. The vicious circle is operated by a network of facilitators and middlemen at all levels of hierarchy. The network of facilitators and middlemen is almost similar to the network through which the feudal network operates in Pakistan and developing countries of similar status, identified in Book: Democracy Displaced In Pakistan, Case History of Disasters of Social Pollution (R&D Publications 1998): Chapter 1.

CPI analysis also shows that the group of countries with CPI score below 4.0 has:

- Its internal energy (ΔH) sapped, entropy increased and wasted energy dispersed and fixed into other forms and structures
- Undergone irreversible conversion of resources into wealth at the hands of organized societies that aimed at domineering another system e.g. member country of CPI Group 3 that lacked driving force with $\Delta G = 0$ or > 0, or at subjugating one with diminishing driving force
- Had to deviate from the Principles of Sustainability, so the development processes are economically unfeasible, socially undesirable and environmentally unendurable.

The group of countries with low CPI score has a disordered governance system. This group has remained in a state of distress all the way. 1998, 2001, 2005, 2007 and 2015 Corruption Perception Index, CPI score has remained low, while the ranking is high. Judged by their position in the 1998 list of 85, the 2001 list of 91 countries and 2013 & 2015 list of 182 countries compiled by Transparency International, it is clearly indicated that they have continued to remain among the socially polluted countries.

Introduction

It has been inferred from earlier parts of the series of papers on Socio-Physicochemical Theory that Development processes aiming to improve quality of life, put the concerned system under stress and inculcate superiority complex among the stressors. Stressors consume the internal energy, ΔH during the stress-strain processes and invariably cause their irreversible degradation and depletion. Since $\Delta H << T\Delta S$, processes aiming at development by resource conversion or requiring external energy input, induce oxidative stress, and are all entropy-driven.

It has further been documented that most development activities are extractive in character in as much as they obtain products from available resources and transform them into different formations and structures, desired product, byproduct and waste products. This explanation is self-evident from Gibbs energy equation: $\Delta G = \Delta H - T\Delta S$, where ΔG is the energy available to be converted to work, ΔH is the enthalpy or internal energy that can be converted into potential energy, kinetic energy, electromagnetic radiation and/or phase changes, while $T.\Delta S$ is the energy that has been worked out and hence not available for useful work.

Expressed in words:
(Total Free energy) = ΔH (Energy available for conversion) – (energy worked out/not available)
Thus ΔG is the energy free to do work, and ΔH is enthalpy or internal energy.

Considering energy available ΔH as available resources, transformation of ΔH into different products will likely be accompanied by increase in entropy, and reduction of ΔG, the driving force of the system, whose resources (internal energy/enthalpy) are depleted to impoverishment. Development activities invariably alter the order and quality of physicochemical parameters and social structures. In terms of Socio-Physicochemical theory the Stressor induces stress on the resources to skim out useful product and leaves the residue degraded. The stressor benefits from the entropy-driven extractive process and emerges at the top of the status pyramid and leaves the residual system under oxidative stress.

The transformation of development processes is translated into equations (1 - 6) which imply that while inducing consolidation of structures e.g. systems emerging from surroundings; solutions yielding solids/crystals; order carving out of disorder; built environment emerging out of disordered system in parallel with the process of crystallization out of a solution, there is an overall impoverishment of resources as suggested by increase in entropy of the systems presented in equations (1 - 6):

$$T.\Delta S_{universe} \cong \Delta(U + PV)_{surrounding} - T.\Delta S_{system} \quad \ldots\ldots (1)$$

$$\Delta S_{system} = \Delta S_{solution} - \Delta S_{solid} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$S_{universe} \sim \Delta S_{disordered} - \Delta S_{ordered} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

$$\approx \Delta S_{Poverty} - \Delta S_{affluence} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

$$S_{universe} = \Delta S_{solution/suspension} - \Delta S_{crystals/solids} \quad \ldots\ldots\ldots (5)$$

$$S_{universe} = \Delta S_{macroenvironment} - \Delta S_{built\ environment} \quad \ldots\ldots (6)$$

It is understandable that there would be an overall alteration in the coherence of physical as well as social structure (order), consolidated or otherwise on changes in reaction conditions and interaction of different components of the social unit as much as in spontaneous interaction. There

would, for example, be an increase in entropy with each socio-physicochemical interaction and intervention or event that may create stress situation in the surrounding or within the system.

The stresses of a coherent society are sequential to application of science and technology (S&T) for industrialization, for improvement in quality of life, and for attaining and maintaining superiority. S&T has helped the progressive societies in providing order and compactness in their physical and social structure. The coherence so achieved has bestowed them superiority, and superiority complex, which they so jealously preserve that they can go to war for preservation. Such societies have had to work hard for their way up the ladder of growth. In terms of Le Chatelier's principle the entire system had to work under pressure to either adjust to the stress or yield to the stress and wear down rapidly.

Impact of stressors on coherence of individuals/groups under stress is analogous to application of force on a body to change its length, volume or shape and cause strains. The deformation of a body is the result of strain in response to the stress. The strain is directly proportional to the force or stress. The ratio between stress and strain is constant for all substances. Likewise there is stress:strain relationship for each system, physical as well as social, compact or otherwise.

Interaction of social systems A and B under stress of stressors is presented in equation:

$$A + B \xrightarrow[\Delta G]{\text{Stressor}} AB^* \text{ (Stressed)} \ldots\ldots\ldots\ldots (7)$$

This equation suggests that stressors initiate interaction between A and B with the driving force ΔG to form the stressed species AB*. Socio-Physicochemical Theory Part – 4 describes the species AB* as hybrid community that has lost at least one degree of freedom for the planes of interaction of species A and B to be in alignment. Loss of one or more degrees of freedom is necessary for stable bond formation and sound social interaction between the two moieties. The stability will be determined by how much free energy is put in by the stressor i.e. the oxidant moiety towards stabilization of bond and maintaining order in social structure.

Virulent communities overcome the inhibiting forces and remain firmly bonded, with capacity to withstand stress. Integrity of others with weak bondage may yield to stress inherent in the system or induced by stressors. The communities may, during communal interaction, first get initiated and charged to form the activated complex AB*, which could split under adequate stress and form species besides AB as in equation (8). All components that skim out may or may not be stable and hence the more stable will survive as the fittest and emerge as the dominant species.

$$A + B \rightarrow AB^* \rightarrow AB + BB + AA + BA + ABB + AAB + \text{(unavailable energy)} \ldots\ldots (8)$$

Formation of species viz. AB, BB, AA, BA etc. other than just AB is dissipation of useful energy into formation of by-products, which would be at the cost of desired product. This amounts to decrease in ΔH and depletion of free energy ΔG due to its transformation into forms of material and energy other than the useful forms. Transformations in which there is increase in unavailable energy forms are considered entropy driven. Production of unwanted species or impurities implies introduction of contaminants or pollutants in solution, abnormalities in production system or social pollution in governance system.

Stresses of Social Pollution

Social pollution as a socio-physicochemical singularity describes an entropy driven social system in terms of distress created by deeds and misdeeds of the social unit. All deeds and misdeeds are acts of social pollution and all acts of social pollution create stresses; they for instance, shift the order – disorder equilibrium from order to disorder and *vice versa*, depending on the severity of the driving force to stabilize or destabilize the system. Socio-Physicochemical Theory is based on the theme developed in earlier publications on Social Pollution: {**SOCIAL POLLUTION & CORRUPTION LEVEL A New Dimension of Environmental Pollution In Global Context**, **DEMOCRATIC INFRASTRUCTURE & SOCIAL POLLUTION**, Corruption & Social Pollution Scenario in Pakistan, Resource Impoverishment - Social Pollution & Poverty Nexus, **SOCIO-PHYSICO-CHEMICAL INTERPRETATION OF POVERTY, CLASS STRUCTURE AND SOCIAL POLLUTION**, Book: Democracy Displaced In Pakistan, Case History of Disasters of Social Pollution (R&D Publications 1998): CHAPTERS I- X; SOCIAL POLLUTION & CORRUPTION LEVEL, Setting Scale to Estimate Social Degeneration In Global Context (2113); SOCIAL POLLUTION & CORRUPTION LEVEL A New Scale that Estimates Social Degeneration In Global Context (2007); SOCIAL POLLUTION: ROOT CAUSE OF TERRORISM; Ideal Society Socialization & Social Pollution, all on ResearchGate site, and Book: Social Pollution and Global Poor Governance, Analysis of Psyche of Governing Hierarchy (1999), Research & Development Publications}. The theme considers the following actions and reactions as acts of Social Pollution:

- Introduction of impurities, unwanted species, contaminants or pollutants in a social group
- Depletion of free energy and dispersion and fixation into forms of wasted energy
- Spontaneous release of free energy with simultaneous change of useful energy or its forms into entropy and random dispersion of the wasted energy and material in the system
- Increase in entropy implying lack of order/randomness and loss of driving force in society/social structure
- Spontaneous increase in entropy inducing randomness in society/social structure
- Irreversible conversion of resources into wealth thus depleting the resources (**ΔH**) and increasing random dispersion of irretrievable forms of energy and material (ΔS)
- Interactions of ordered/organized societies aimed at domineering another system/group that lacks driving force with $\Delta G = 0$ or > 0, or at subjugating one with diminishing driving force, and depletion of free energy of the system
- Spontaneous release of free energy with simultaneous change of useful energy or its forms during use of force by organized/unorganized social groups for dominating over another system or group
- Deviations from the Principles of Sustainability: Development Processes need to be economically viable, socially acceptable and environmentally bearable.
- Deviations from norms of a society
- Forcing to deviate from norms of society

Application of above codes to processes of social pollution indicates that societies, which employ entropy-driven techniques and high specific reaction rates for up-gradation of quality of life and enhancement in quality of environment follow the order-disorder equation (3,4) to carve out order from disorder as in equation (5, 6, 10, 11). They transform the resources of the Earth into wealth/richness/affluence at varying rate, and in doing so set new lows for impoverishment and greater heights for affluence. The end result is increase in entropy of the universe as in equation (3, 4, 9).

$\Delta G = \Delta H - T\Delta S$ …… (1)

$\ln K_{eq} = -\Delta H°/RT + \Delta S°/R$ …….. (9)

$S_{univ} = \Delta S_{solution/suspension} - \Delta S_{crystals/solids}$ ..... (5)

$\Delta S_{universe} \cong \Delta S_{global\ environment} - \Delta S_{macroenvironment} - \Delta S_{microenvironment}$ … (10)

$S_{univ} = \Delta S_{macroenvironment} - \Delta S_{microenvironment}$ ..... (11)

$S_{univ} = \Delta S_{macroenvironment} - \Delta S_{built\ environment}$ .....(6)

$S_{universe} \sim \Delta S_{disordered} - \Delta S_{ordered} \approx \Delta S_{Poverty} - \Delta S_{affluence}$ ..... (3,4)

***Production of Order from Disorder*:** Precipitation leading to micro-crystallization is a typical example of exothermic reactions in which solids in crystal form, considered in an ordered state, are formed from disordered gaseous or liquid phases. It may be noted that it is difficult to have an ordered state in a heated

atmosphere, or in an agitated social gathering charged with emotions with $\Delta G < 0$ and high values of $T.\Delta S$. This observation suggests that the forward reaction that transforms and fixes ΔH into product in an ordered state brings order in the society by consuming resources. It may be reversed by negative forces, for example by acts of terrorism that create chaos and disorder.

$$S_{univ} \sim \Delta S_{disordered} - \Delta S_{ordered} \quad \text{..... (3)}$$

It further suggests that ***order and disorder can co-exist if the severity of driving force of the respective systems is neither domineering nor subjugative but in balance. Their balance needs to be keenly managed so as not to allow entropy to dominate over enthalpy, or else there will be catastrophic end.***

In the context of equation [$T.\Delta S_{universe} \sim \Delta H_{surrounding} - T.\Delta S_{system}$ …. (1)] and (5), it may be inferred that order is expressed out of disorder, in the same manner as crystals separate out in ordered state from solutions that lack an ordered state. By analogy development processes convert resources e.g. open land ($\Delta H_{surrounding}$) into clusters of organized structures and leave the surrounding land unorganized. They, while depleting the resources (ΔH) of the system, fix them into less available/unavailable forms of internal energy, and hence are cause for overall increase in entropy of the universe.

These considerations suggest that it is natural for elitist societies that have carved out affluence from impoverishment and achieved prosperity, to conserve the potential and maintain their ordered/organized status and higher values, by keeping the poverty ≈ affluence and order ≈ disorder equilibrium given by K_{eq} in equation (9) in favour of organized state. In the light of equation (12) the industrially advanced countries have skimmed out steadily as well as rapidly into socially coherent, economically stable and technologically advanced states, from the rest of the world comprising the unorganized and semi-organized systems:

$$S_{universe} \approx \Delta S_{socially\ polluted} - \Delta S_{socially\ coherent} \quad \text{..... (12)}$$

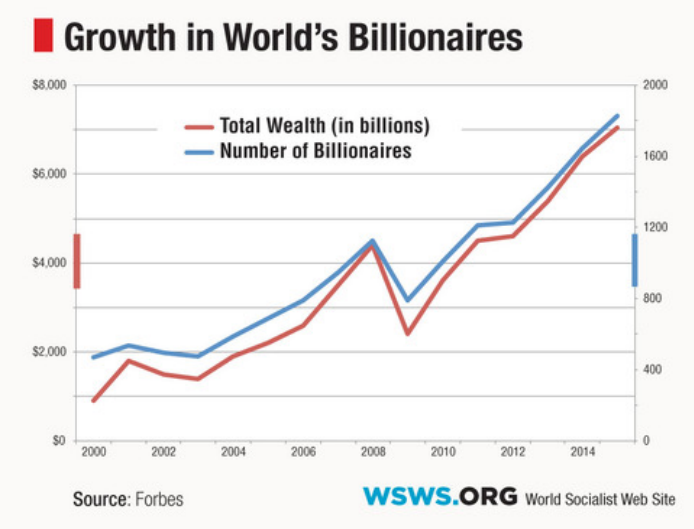
On the other hand societies that have undergone decadence due to inadequacies of resources (ΔH), $\Delta G > 0$, and higher entropy (ΔS), will find it hard to maintain a forward rate of reaction and/or to resist the backward reaction processes such as ingress of social pollution of order ranging from stress and depression to state sponsored terrorism. Organized societies will, in order not to yield to the pressure of stressors as in equation (7) get charged up into an excited state (Part 2 of this series).

The semi-organized systems emerging as the industrializing countries among the rest of the world have, on realization that they have been left behind, started in the mid-50s to industrialize and are now using technology to catch up with the industrialized countries at the fastest rate characterized by spontaneous reactions with $\Delta G < 0$ and high entropy. The process of status up-gradation by industrialized as well as industrializing countries and individuals by conversion into unavailable forms of energy/material, has been at the cost to resources (ΔH) and social norms. Conversion of resources into wealth should meet the sustainability criteria by, for example recycling the harvested wealth into the very system from which it has been extracted. Accumulation of wealth without meeting the criterion just stated constitutes an act of social pollution. Socio-Physicochemical Theory finds that the current development processes fall terribly short of meeting the sustainability criteria.

The situation of the car market elucidates the gravity of the issue. Cars once produced comprise conversion of resources and fixing them into unavailable forms of material and energy. The cars are expected to serve their useful purpose once they are on road. They however, lose their value as a new car within a year. That creates a sub-system comprising the market for used cars. Sustainability principles and also the market forces demand maintenance of balance between new and used cars. Used cars also have lifetime limitations i.e. their use is limited to a few cycles after which they end up as trash waiting for technology to extract the valuables, if any from the trash. Car production is several-billion-dollar entropy-driven industry, implying governance of a chain of systems that upgrades the resource to product and locks it up in irreversible form.

The process of degradation sets up soon hereafter and products while passing through several sub-systems lose the value in terms of enthalpy (ΔH) and increase in entropy when it ends up as trash. The system of car production is entropy driven in that there is depreciation of the value and increase in entropy as the cars pass through different sub-systems. The cash generated in each sub-system is not recycled into production system but is transformed into different modes either for enjoying the richness, or investing into irretrievable forms to derive benefits of much greater wealth by manipulating it in some safe haven. Actions like the one just cited have increased the entropy of the earth to critical limits, while accumulation of wealth without meeting the sustainability criteria constitutes an act of social pollution. Socio-Physicochemical Theory finds that the current system of production and marketing does not meet the sustainability criteria.

Private wealth accumulation likewise does not meet the sustainability criteria. Firstly because it (wealth accumulation) is the result of conversion of resources into irretrievable forms, secondly the aim of conversion is extraction of benefits, followed thirdly by transforming the benefits into forms (for example wealth) that are detached from sustainable development processes, and finally ending up in waste and wasted energy. The process of wealth accumulation and fixing the benefits into selfish gains is entropy driven. In Part 4 of this series it was mentioned that Global private wealth accumulation had reached $263 trillion in 2014; it now stands at over $280 trillion. It may lead to the inference that an equivalent of $280 trillion has been fixed into forms unavailable to the industry or the land whose resources were extracted. The number of billionaires had increased to 1826 in 2014. Their aggregate net worth: $6.5 trillion, in 2015 was less by $570 million than last year. The number of ultra-rich people with $30m or more in assets is now 187,500. They controlled $19.3tn in assets, suggesting that the ultra-rich had converted $19.3tn worth of resources into irreversibly unavailable forms. The 13.3 million dollar millionaires around the globe together hold assets worth $66tn. All in all the millionaires and billionaires i.e. the rich and ultra-rich have converted over $91.8tn worth of resources into wealth and fixed them in irreversible and inaccessible forms. (http://www.cnbc.com/id/101105809#.),(http://www.knightfrank.com/wealthreport/2016/wealth-distribution/uhnwi-growth-2016) .



Launching on development activities without meeting the requirements of sustainability principles results in fixing the resources into irreversible and inaccessible forms. Deviations from the Principles of Sustainability: Development Processes need to be economically viable, socially acceptable and environmentally bearable, constitutes an act of social pollution, which is so far not a cognizable offence. Additionally it is cause for inequality in the acquisition and distribution of wealth.

Corruption Perception Index

The process of industrialization has, while following the principles underlying equation (12) skimmed out the potentially robust economies from the rest of the world comprising the unorganized and semi-organized states. The former emerged as socially coherent, economically stable and technologically advanced

countries. The semi-organized states started late while the unorganized states did so much later to upgrade their status by using technology. To catch up with the industrialized countries some of the two groups took the fast track characterized by rates of spontaneous reactions that have $\Delta G < 0$ and high entropy. The process of status up-gradation passed through {conversion of resources (ΔH)} → (energy/material form) → (harvesting) + (accumulation of wealth)} did not follow the sustainability principles. Countries which do not follow the sustainability principles in their efforts at status up-gradation do commit acts of social pollution of varying degrees. Organized, semi-organized and unorganized communities and countries can be grouped into the corresponding categories on the basis of Sustainability Criteria:

- The first group consists of organized states that are highly ordered and relatively less stressful; they follow democratic principles in letter and spirit. This group has the capacity to deal with stresses of social pollution. Stresses of lower order produced within the system are dealt with locally.
- The second set of states/groups is ordered, but stressful, and is among social pollution stressors. Hence, besides having the capacity to deal with stresses, this group engages in committing acts of social pollution within as well as outside its domain.
- The third group comprises communities/ nation states with diminishing political freedom; they are under serious stress of social pollution both within and outside its domain.

The first group adopts fair means in its operations. The second group has the capacity to enhance market forces to open the economies of developing countries for their products; it imposes corruption induced in its own system on weak economies that comprises the third group.

A similar set of 3 or 4 group of states is arrived at from an analysis of Corruption Perception Index, CPI, which is being published for almost all countries each year by Transparency International (TI) since the mid-1990s. The CPI scale has been developed in respect of the values attached by the society to democracy and trade. CPI Score developed by Transparency International relates to perceptions of the severity of corruption as observed by business people, risk analysts and the general public; it ranges between 10 (highly clean) and 0 (highly corrupt). For arriving at the CPI scale/score it uses surveys to assess the performance of the nation/state.

CPI has been adopted in the present studies on Socio-Physicochemical Theory as a pointer of Social Pollution Level (SPL). [(SOCIAL POLLUTION & CORRUPTION LEVEL, A New Dimension of Environmental Pollution, https://www.researchgate.net/publication/281445430_SOCIAL_POLLUTION_CORRUPTION_LEVEL_A_New_Dimension_of_Environmental_Pollution_In_Global_Context), and (SOCIAL POLLUTION & CORRUPTION LEVEL, https://www.researchgate.net/publication/275874678_SOCIAL_POLLUTION_CORRUPTION_LEVEL_Setting_Scale_to_Estimate_Social_Degeneration_In_Global_Context_2013)] Analysis of CPI scores shows that Deviations from the Principles of Sustainability, which require economic processes to be viable, social processes to be acceptable and environmental process to be bearable, and all three to remain in balance. Good Governance follows Sustainability Criteria and tries to maintain a balance arrived at in equation (3 & 4):

$$S_{universe} \sim \Delta S_{disordered} - \Delta S_{ordered} \approx \Delta S_{Impoverishment} - \Delta S_{affluence} \quad \text{..... (3, 4)}$$

Since order has skimmed out from disorder and affluence out of impoverishment, order and disorder are required to follow the Sustainability principles for co-existence. The two extremes can co-exist in the same manner as in the bond of a chemical entity, where the bonding and anti-bonding forces are in balance. The co-existence will be possible if the severity of driving force of the respective systems is neither domineering nor subjugative but is in balance. Their balance needs to be keenly managed so as not to allow entropy to dominate over enthalpy, or else there will be catastrophic end.

Governance by sustainability principles has no room for the formal (ordered) and informal (disordered) systems to run in conflict with one another, since the informal system on the driving seat will operate the vicious circle and degrade the governance system. Genuine democratic processes have been instrumental in eradicating the evils of social pollution and reducing the disorderliness of the societies concerned.

However, a mix of social pollution into democratic processes yields to ***kleptocratic*** processes which allow room for evil forces to operate the vicious circle and that eradicates the evil forces only to a limited extent.

> **Kleptocracy** is a form of political and Government corruption where the government is engaged in increasing the personal wealth and political power of its officials and the ruling class at the expense of the wider population, often pretending to offer honest services. Such governance system is generally considered corrupt, and the mechanism of action is invariably embezzlement of state funds. In abstract terms, it is simply, rule by thieves.

Governance by genuine democratic processes is like promoting the cause of ideal society and hence the governing hierarchy is generally reluctant to allow sustainable systems to operate in place of *laissez faire* in its systems (https://www.researchgate.net/publication/275346178_Ideal_Society_Socialization_Social_Pollution). Analysis of CPI scores distributes all the countries of the world in terms of varying degrees of social pollution and the different group of countries in respect of operation of democratic or kleptocratic processes:

CPI Group 1

Analyses of CPI scores ((SOCIAL POLLUTION & CORRUPTION LEVEL, A New Dimension of Environmental Pollution, https://www.researchgate.net/publication/281445430_SOCIAL_POLLUTION_CORRUPTION_LEVEL_A_New_Dimension_of_Environmental_Pollution_In_Global_Context)) suggests that Group 1 comprises countries which follow the sustainability principles to the maximum. Development Processes in these countries are economically viable, socially acceptable and environmentally bearable. Their actions generally do not deviate from sustainability principles nor are their norms forced on other social groups. They have attended to eradication of social pollution and to reduction of disorderliness in their governance system.

This group is composed of 10 countries that have CPI score ranging above 8.5; they rank among the top ten in CPI ranking. In the mid-1990s Finland was on top with CPI score 9.9, followed by Denmark 9.5, New Zealand 9.4, Iceland 9.2, Singapore 9.2, Sweden 9.2, Canada 8.9, Netherlands 8.8, Luxemburg 8.7 and Norway 8.6. The high CPI score in the 1990s suggests that these countries were relatively less involved in acts of social pollution. Their interactions were not aimed at domineering another group that may be lacking the driving force with $\Delta G = 0$ or > 0, or at subjugating one with diminishing driving force. They had the reputation of being unconcerned with pushing in democracy, and in enhancing market forces to open the economy of other countries for their products. They were not directly participating in the affairs of cold war and they did not have a large network of MNCs nor were their corporations ambitious in getting their products in by any means. The secret of their success was honesty, commitment to quality control and non-interference in affairs of others. More recent CPI scores of the above class of countries shows a decline in their position. This among other matters suggests the possibility of degenerative forces of social pollution creeping in their social structure.

Closer examination of the characteristics of these High-CPI – Low-Ranking countries suggests that their system of governance is neither autocratic nor bureaucratic, but is merit-based i.e. their actions and inactions are weighted against merit. Their social structure is dynamic. High literacy rate and education in the language of the people characterizes their society. There is no gender bias and women are an integral part of the work force. Other characteristics include an exemplary public order that has systematically skimmed out from a disordered system through local government and honest judiciary. They were not colonized by a foreign government and hence do not have the oligarchy or parasitic social elites with feudal psychological frame of mind to govern the affairs of the government. They have all been through civil wars, which put their nationhood at stake; the war was among patriots. The system of governance was the issue during their civil wars. None of their citizens is dubbed a traitor nor dehumanized in like manner. Their armed services and nuclear weaponry are firmly in the hands of appropriate responsible authorities. They are all highly urbanized and have no concept of rural landownership or of the landlords being a dominant political force. Agricultural production accounts for 20 percent of the GDP but they are self-sufficient in

basic food grains. They have a set of highly developed political parties, governed by an internal electoral process. The parties function alongside the bureaucracy in all tiers of the government. Their stable body politic implements full authority of the state; it allows no room for parallel governance system or for kleptocracy.

CPI Group 2

The Second group in CPI ranking comprises countries which follow the sustainability principles in manner that suits their purpose. Their actions generally deviate from sustainability principles and they do force their standards for domineering other social structures. They have attended to eradication of social pollution in their own way but have introduced several avenues of corruption rather than doing away with it. They have reduced the disorderliness in their governance system and have actively converted theirs as well as others resources irreversibly into wealth and secreted it in havens on and offshore, thus besides depleting the resources (ΔH) they have increased random dispersion of wasted energy and material (ΔS). They are also active in militarism, in arms production and acts aimed at domineering another system/group that lacks driving force with $\Delta G = 0$ or > 0, or at subjugating one with diminishing driving force. With the typical capacity to deplete the free energy of a system this group may be characterized as potential oxidant (Science for Supremacy & Demands of New Economic Order, https://www.researchgate.net/publication/278328770_Science_for_Supremacy_New_Economic_Order).

This group of countries is composed of entities with and without sufficient bond energy uniting them. As such some of them yield to stress and split forming species such as in equation (8), while virulent entities emerge as independent units, each asserting its identity and seeking improvement in status. Governments may split into formal and informal; democratic and pseudo democratic, and autocratic and kleptocratic systems of governance. This may lead to formation of parallel governments and degrade the formal system. Individuals improve their status by intensifying the driving force for conversion of resources into wealth. This has led to substantial increase in the number of millionaires and billionaires, in the number of rich and super rich, and in the conversion of several trillion dollar worth of resources into wealth and arms. This has been achieved not by pooling up the resources or sharing the richness in resources and technology globally, but by giving strength to the long handle of social pollution to globalize corruption.

The CPI score of this group ranges from 4.0 to 8.5. In earlier years 35 countries ranking from 11 to 45 were listed in this group. Analysis of the CPI score shows that countries with CPI score above 4.0 attain the capacity to influence weak economies, while those with score above 6.0 have the driving force to dictate terms of trade and exploit resources of weaker and emerging economies. Most members in this group exploit others resources, and as AID donors they force their ways and dictate terms of trade in their favour.

The group of countries with CPI score ranging between 6.0 and 8.5 exploits the competing commercial interests among the developing and yet-to-develop countries against one another. The majority in such democratic systems produces legislation that is helpful to itself and damaging if not destructive to the minority. Quite often the rich minority rules over the poor majority and a tiny minority of 62 people owns the same as half the world {Oxfam Davos report (https://www.oxfam.org/en/pressroom/pressreleases/2016-01-18/)}. The oligarchy (System in which all power is vested in a dominant class) in this group of countries promotes collaboration between the governing hierarchy and multinational corporations. Collaboration helps the former in gaining control over the masses by keeping them engaged politically but impoverished socially and economically. It also helps the latter in perpetuating the economic and political agenda, while the network of exploiters also notorious as kleptocrats enjoys being part of the deal that helps them siphoning dirty money and in enjoying the richness.

The group of countries whose CPI score is 6.0 to 8.5 has incidentally a large network of MNCs through which corruption induced in their own system is imposed on weak economies. This group includes Japan with CPI 7.1 ranking at 21, Germany CPI 7.4 at 20, USA and Israel both with CPI score of 7.6 and ranking

at 17 and 16 respectively, United Kingdom with CPI 8.3 at 13 and Australia with CPI 8.5 ranking at 11. East Asian economies viz. South Korea placed at 43rd with CPI score 4.2, Taiwan at 27th with 5.9 and Malaysia at 36th with CPI 5.0, which have been in turmoil also fall in this group and they are known to have ascended the growth ladder by exploiting others resources e.g. the interest of Taiwan in making investments in setting up industries in developing countries around the world.

United States of America, Japan, United Kingdom, Germany, France, Russia, Turkey, China, India and in fact the current top economies of the world are different from others because of the profound socioeconomic transformation of their societies to achieve stability, as against sustainability, for their organized and semi-organized structures. Their agricultural production system has been transformed by mechanizing and managing the key natural resources. They are not vulnerable for their energy requirement. Their autarky in steel production, and engineering industry provides them a comprehensive industrial base, which contributes to their superiority over all others in the north and south. They employ these capabilities to evolve such external trade patterns that do not make them vulnerable to financial or commodity blackmail. Above all they have a national goal and a commitment to achieve certain targets. It may be seen that it is by virtue of their inherent strength that they skimmed out of disorder, and on having achieved the ordered status, the top and emerging economies are able to exploit their own as well as others resources of minerals, energy and nuclear capability.

Countries with medium level CPI (6.0 – 8.5) have since the end of World War II been following the Bretton Woods Agreements and working for ***democratizing capitalism*** **and** ***mixing-in militarism***. With large size of their economy, they have been able to harness the driving force for enjoying-the-richness psyche, and to ***mix-in militarism*** for achieving supremacy in trade and arms. There is no serious commitment from them for changing their psyche to the sustainable process of sharing-the-resources in an attempt to break the vicious circle, which is responsible for inducing corruption/social pollution, and disfavouring virtuous circle. The vicious circle is operated by a network of facilitators and middlemen at all levels of hierarchy. The network of facilitators and middlemen is almost similar to the network through which the feudal network operates in Pakistan and developing countries of similar status, identified in Book: Democracy Displaced In Pakistan, Case History of Disasters of Social Pollution (R&D Publications 1998): Chapter 1, where it has been stated:

> [The *zamindars* (landlords) have been operating through what are known as *patharedars*. The patharedar has historically been counted among the notables of his area. He has, since the times of the Iranian, Moghals, Portugese, British and Afghan invasions, been serving as the provider, protector, patron of dacoits, criminals, cattle lifters, kidnappers, smugglers, and keeping the zamindar safe from the reach of law and revenue administrators, from the times in the distant past to the present. Being a very influential person, he cannot be arrested nor can any of his men be arrested by any party or government agency, howsoever strong.]

The *patharedari* system has now been formalized and globalized. Operations of facilitators and middlemen in modern times are assigned to NGOs which deliver the desired information/material/goods/armour/assets in exactly the same manner as the facilitator/middle man has been doing in the *patharedari* system since the historical past. Operations of the dacoit arm of the *patharedari* system has been strengthened by militarizing its fleet and providing arms that enables resistance for a few days. The system has gained sufficient strength to run parallel economy.

The national psyche in Pakistan and other countries with low CPI score and high SPL (Social Pollution Level) is governed by parasitic elites who operate the vicious circle of social pollution. Those in the governing hierarchy are internal colonists who have invariably sapped the energy and strength of their country and retarded their progress virtually at each stage. It has, however, been observed that it is the psychological framework or psyche of organized as well as unorganized system which governs the actions

of the oligarchy and governing hierarchy. Kleptocracy, as one of the different forms of *patharedari* system, skims off the benefits, locks them into unavailable forms or transfers them into safe haven offshore, increasing the entropy of the system in each case. *(Social Pollution & Global Poor Governance, Analysis of Psyche of Governing Hierarchy, Mirza Arshad Ali Beg, Research & Development Publications, Karachi, 1999, **Socio-Physicochemical Interpretation of Poverty, Class Structure and Social Pollution**), Corruption & Social Pollution Scenario in Pakistan, https://www.researchgate.net/profile/Mirza_Beg5/contributions, Resource Impoverishment - Social Pollution & Poverty Nexus, Mirza Arshad Ali Beg https://www.researchgate.net/publication/280742560_Resource_Impoverishment_-_Social_Pollution_Poverty_Nexus?ev=prf_pub; Globalization of Corruption with Changes in World Economic Order, Mirza Arshad Ali Beg, https://www.researchgate.net/publication/275952755_Globalization_of_Corruption_with_Changes_in_World_Economic_Order], SOCIAL POLLUTION & CORRUPTION LEVEL Setting Scale to Estimate Social Degeneration In Global Context (2113), Mirza Arshad Ali Beg, https://www.researchgate.net/publication/275874678_SOCIAL_POLLUTION_CORRUPTION_LEVEL_Setting_Scale_to_Estimate_Social_Degeneration_In_Global_Context_2113]*

Countries in CPI Group 1 and 2, with score ranging from 4.1 to 9.1 although characterized as open, transparent, and liberal democracies with a free press and independent judiciary, have the democracy under siege from corporate capital. This has rendered the democratic processes in their countries dysfunctional and pushed the democratic infrastructure of the countries in siege, into shambles. It has been stated in an earlier publication: "The informal feudal or elitist infrastructure is cause for costly failure of the governance system of the country mainly because it is ill-concerned about the impoverishment of resources resulting from its internalizing the benefits to itself. The imperatives for successful operation of democratic systems by the people, for the people and of the people are difficult to obtain in socially polluted systems. Similarly a self-sustained infrastructure comprising institutions to govern justice and welfare of the society, and to maintain its purity without getting influenced by the pressure groups, being ideal, is almost a dream. (https://www.researchgate.net/publication/281445324_DEMOCRATIC_INFRASTRUCTURE_SOCIAL_POLLUTION)

It is useful to quote Jeffrey Sachs, (http://www.theguardian.com/commentisfree/2016/may/12/anti-corruption-summit-us-united-kingdom-tax-havens): "The UK and the US are at center of the system of global abuse. Britain created the modern world of global finance in the 19th and early 20th centuries, and Wall Street became co-leader with the City of London after World War II. In both countries, hundreds of thousands of lawyers, bankers, hedge fund operators, politicians, accountants and regulators have consciously built a system of global tax havens of the rich, by the rich, and for the rich that now hosts more than $20tn of funds hiding from taxes, law authorities, environmental regulators and accountability bureaus".

"As serious and tragic as is the corruption in Nigeria, Afghanistan and elsewhere, it has long been facilitated by the UK itself (including the transfer through Royal Dutch Shell, not just tax havens). We should distinguish the big and small operators." In the same Anti-Corruption Conference the Prime Minister of UK cast doubt on whether United States can be part of 'coalition of the committed' since the tax haven in the USA are just as numerous as elsewhere in the world.

It is not just the Countries in CPI group 1 and 2 that are socially and morally polluted but perhaps the system is deranged in all countries of the world, that includes their oligarchy and kleptocracy, the difference is only in degree and not in kind. This upholds the corollary of the Theory: ***Order and disorder can co-exist if the severity of driving force of the respective systems is neither domineering nor subjugative but is in balance. Their balance needs to be keenly managed so as not to allow entropy to dominate over enthalpy, or else there will be catastrophic end.*** The inference drawn is that wherever Governance system does not follow the Sustainability Criteria for skimming out order from disorder and extracting affluence from an impoverished environment, order or affluence will take over the driving seat of kleptocracy as follows:

$$S_{universe} \sim \Delta S_{disordered} - \Delta S_{ordered} \approx \Delta S_{Impoverishment} - \Delta S_{affluence} \text{ ..... } (3,4)$$

The long handle of social pollution is ruling supreme over the global financial system; it has converted $21tn - $31tn worth of resources into wealth and stashed it in tax havens. All in all there is about $92tn worth of resource conversion that is stashed in tax havens maintained and supported by large and small operators, with protection provided by oligarchs and kleptocrats who have a prominent position in their parliaments.

CPI Group 3

This group comprises countries that have

- Their internal energy (ΔH) sapped, entropy increased and wasted energy dispersed and fixed into other forms and structures
- Undergone irreversible conversion of resources into wealth at the hands of organized societies that aimed at domineering another system e.g. member country of CPI Group 3 that lacked driving force with $\Delta G = 0$ or > 0, or at subjugating one with diminishing driving force
- Had to deviate from the Principles of Sustainability, so the development processes are economically unfeasible, socially undesirable and environmentally unendurable.

The CPI Group 3 countries have a disordered governance system. This group has not attended to eradication of social pollution and remains in a state of distress. In this group of countries the same few people exchange the top positions to form the government. When the number of parties is large, even a minority enters the corridor of power as a result of division or wastage of votes or else through rigging. Interestingly their 1998, 2001, 2005, 2007 and 2015 Corruption Perception Index, CPI score has remained low, while the ranking is high. Judged by their position in the 1998 list of 85, the 2001 list of 91 countries and 2013 & 2015 list of 182 countries compiled by Transparency International, it is clearly indicated that they have continued to remain among the socially polluted countries.

CPI analysis suggests that Pakistan is among the group of countries which have a CPI score of less than 4.0 and is among those where the level of social pollution is high. In the earlier years Russia had the same CPI as Pakistan and ranked at 81; Brazil with 4.0 was at 46, Mexico with 3.7 was at 51, Egypt and Turkey both with 3.6 were at 54 and 56, Argentina and China both with 3.5 were at 57 and 58, Thailand with 3.2 was at 62, Philippines with 2.9 was at 66, India with 2.7 was at 72, Cameroon and Kenya both with 2.0 were at 86 and 87, Indonesia CPI 1.9 was at 88, Nigeria CPI 1.0 at 90 while Bangladesh with 0.4 ranked at 91.

Pakistan had a CPI score of 2.3 and ranked 80th among 91 countries in the 2001 CPI ranking. In 1998 Pakistan's score was 2.7 and it ranked 72nd in the list of 85 countries which shows that it had gone to lower levels of social pollution during the earlier three years. In 2015 it ranked at 117 but had CPI score 3.0, showing only marginal improvement. Social pollution in Indonesia was at the highest level indicated by the CPI score of 1.9 and ranking at 88th position among the 91 countries. This high level indicated the dearth of public trust in the government and rise in frustration over the lack of change of economic fortunes and genuine political reforms. Indonesia has improved its position considerably in the list of 182 countries where its CPI score is 3.6 and ranks at 88th position in 2015.