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The Climate Change System Introduction Part 2

1. The Earth Planetary System

The Earth planetary system is very robust. At present we are having an inner core of 1.500 miles in diameter composed of iron and heavy metals, an outer core of 1.400 miles, a lower mantle of 1.400 miles, upper mantle of 400 miles and the crust of 2–45 miles in diameter.

On the top of the crust, there are permanent dynamic changes caused by the natural powers by which the Earth's surface was/is shaped. And the atmosphere is covering, protecting and completing the biosphere of the planet up to 650 miles or 1.000 kilometers, where the Exosphere is ending into the outer space. The main subsystems of the Earth are: its planetary body, its Moon, and its atmosphere. Its planetary body has got 8.000 miles or 13.000 kilometers in diameter. The Earth is the fifth planet by diameter, the largest one is Jupiter with an eleven times larger diameter, and the smallest one is Pluto[1] with around one fifth of the Earth's diameter. The surface of the Earth together with its atmosphere is making its biosphere, where we live and where the life has been a part of its system for more than 3.8 billion years. At that time in history the first appearance of the microbial life could be placed.

Among the life supporting components of the Earth, oxygen is most important element. It forms:

- two inorganic oxides – water and carbon dioxide, which are the life supporting molecules;
- atmosphere with oxygen molecules in the breathing air,
- the ozone layer as the protection against UV rays.

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[1] New 2 outer planets data are not yet known to author, also one missing planet could be questionable content within present status of the Solar System.

After setting such a support within the system of the biosphere the appearance of life on Earth was just a matter of time.

The outer supporting part of the Earth is the flow of light and warmth from the Sun, which is enabled by the Earth's adequate distance from the Sun, actually, and supports life on Earth rather then prevents it, which is the case on the Earth's neighboring planets the Venus and the Mars.

The unique composition of the planet Earth and its distance from the Sun are two major qualities that have evolved with evolvement of the Solar System and are making the basic possibility for the life to appear on the Earth at present.

The Earth crust surface, at present, is made of a terrestrial part, which is covering around 30 percent of the surface, and of ocean/sea waters cover taking the remaining 70 percent of the surface. The ratio between oceans and lands was changing with dynamic changes of the Earth surface evolvements. The first appearance of the water on the Earth was the deciding factor for the formation of its surface and atmosphere. After cooling down the atmosphere was thick and much lower than now. The primordial atmosphere was oxygen free. A big change was the appearance of the first life forms, which have been anaerobic microbial organisms living without oxygen. They were gaining the necessary hydrogen for their synthesis of different organic carbon compounds from dissolved inorganic compounds of carbon. It took hundreds of millions of years for them to change the primordial Earth from its anaerobic to its aerobic stage. Their significant contribution was the sink of carbon dioxide, when their dead cells came down as sediment to the bottom of the oceans, where they have been transformed into numerous carbon compounds and that we see today as fossil fuels. It was the time of the first energy transformation, actually those organisms transformed sugar molecules to gain two units of energy per molecule.

In the next generation microbes were able to split water molecules with assistance of the light from the Sun, and used the released hydrogen to reduce the carbon dioxide molecules. By this photosynthesis a rich biomass was produced. The end product of this reaction was the molecular oxygen, but its appearance was poisonous for the existing life creatures. It changed the life entirely, and the new generation of microbes was able to use oxygen as its oxidation of biomass by respiration. It was the first energy transition on the Earth, because with such a transformation of the sugar molecule they gained 36 energy units or eighteen times more that the anaerobic microbes.

The carbon dioxide was a part of water due to its solubility, and oxygen that was not solvable in water, became an integral part of the atmosphere. The concentration of the oxygen in the atmosphere was increasing and changing, and settled at 21%, with 78% of nitrogen, and the remaining 1% was made of carbon dioxide,

methane, and some other gaseous elements. With appearance of oxygen in the atmosphere, with influence from the Sun radiation the oxygen molecule was split down to the elementary oxygen, which in the upper layers of atmosphere made the three-valence oxygen molecule ozone. With time the ozone formed an UV impermeable screen or ozone protection layer against those rays from the Sun, which have been responsible for decomposition of the dioxide molecules – the UV rays. The biosphere on the Earth responded with evolution of life, its intensification and transition from water to the Earth's terrestrial parts. The bacterial life moved on the terrestrial part of the surface, formed on the crust top a carbon rich layer, which eventually became what we today call soil. The Earth system evolved to the stage when complex life forms were able to appear. It was some 700 hundred millions years ago, and land mammals appeared some 350 millions years ago. The human predecessors are dated some 8 millions years ago, and Homo sapiens, our predecessor, some 100.000 years ago.

So here we are – we have the Universe, the Milky Way, the Solar System, the Planet Earth System, and the life on the surface of its terrestrial and aquatic part as well as within its atmosphere. With the existing input/output effects from superior systems, especially the Solar System, with evolved parts of the Earth system, etc., the climate change system became the provider, maker, holder, and guardian of living conditions within the biosphere.

2. Requisitely Holistic/Systemic Thinking – Basic Principles Applied to the Climate Change System

System thinking, synthesis, analysis, complex problem solving, case study approach, classical science and research and learning, learning and learning are prerequisites for opening of the Nature knowledge box, which is main goal for research and success of our civilization. Precondition for sustainable future is directly related to ability of humans for support/interdisciplinary research application for this purpose.

History and status of the system could be known, near future also in case of continuity, but predicting of the future could be done only in case of stabile status of the system. We had over 10.000 years of stability, but now not more, due to destabilization of the climate change system. Due to triggering effect of our civilization and natural responds to that effect, at moment is quite impossible to predict any relevant information on future evolvements of the Biosphere.

The described facts, though, do not mean that there is no impact of us humans over the climate change system. We do have an impact, and its contents de-

pend a lot on our own thinking and behavior. Our one-sidedness is quite natural and equally dangerous at the same time, potentially leading to our own extinction. We should better add something to it, which is called holistic/systemic thinking. It is briefed in the table 1.

Table 1. The basic seven groups of terms of systems / systemic / holistic versus non--systemic thinking[2]

Systems / systemic / holistic thinking	Unsystemic, traditional thinking
Interdependence/s, relation/s, openness, interconnectedness	Independence, one-way-dependence, closeness
Complexity (plus complicatedness)	Simplicity, or Complicatedness
Attractor/s	No influential force/s, but isolation
Emergence	No process of making new attributes
Synergy, system, synthesis	No new attributes resulting from relations between elements
Whole, holism, big picture	Parts and partial attributes only
Networking, interaction, interplay	No mutual influences

The climate change system is an integral part of the Planet Earth biosphere. It has no clear-cut borders with other systems in the nature, like we humans are used to think and see. The climate change system is rather a part and complex natural system that actively takes/uses/ puts/gives inputs/influences/impacts, receives outputs/influences/impacts from all inferior and superior systems, and reflects the present ones – as living conditions at the very moment of observation. Observer can go back in the history of evolvements, but cannot go in the future, due to countless possibilities involved.

The difference between the human's traditional thinking and the system thinking could be described as follows, when concerned with the climate change system: when observers look at our civilization's achievement from the viewpoint of building and construction heritage, it looks nice, everything is in order, the arcs are arcs, lines are in a geometric order, and the whole construction follows a certain tradition/style/architect's mind work. Of course not as a total rule, because e.g. the great architect from Catalonia, Gaudi, has demonstrated his innovative approach to churches and other constructions. Also our houses, exterior and interior arrangements, agricultural activities, communications, roads/railways etc., are following a certain order, which does not look like the virgin nature. To us humans from this civilization the virgin nature looks like chaos, and we are not in position

[2] From Prof. Emeritus Dr. Matjaz Mulej, Maribor, Slovenia, The Dialectical Systems Theory, presented at book *System Thinking and Climate Change System* displayed at www.institut-climatechange.si

to see that it sees us vice versa. It is also difficult to comment whether the distance between nature and the human life style is now big or small, but it is obvious that we humans have made many different interventions/innovations, which are not a natural way of acting. So, for the conventional thinking chaos of nature is chaos, and our life style is all right. On other hand the system theory/thinking may allow us humans to see the natural chaos as order and the human's order as a sort of chaos. When not only scientists, but also common people in the local communities will have this ability, we shall have much more of a natural habitat as we do now.

When we apply the above findings to the climate change system, we may understand "chaos" as interdependences/interactions/co-operation of many different systems of nature resulting from parts of the very complex climate change system. Of course we should not forget that this thinking is the thinking of human beings, and it has all good and bad attributes, which we humans have. The climate change system is a composition of a permanent evolution of the natural systems, which support the biosphere as the space for living creatures within nature. We have seen dependences of the climate change on its superior systems, and let us first list the influences, which may occur from them to the biosphere.

All changes/evolvements of the Sun System have an absolute impact on the biosphere. They have a strong impact on the Earth, and most probably grave consequences when changes at the Sun System evolve. More scientific research should be directed towards understanding of effects from the Sun on evolvements of our biosphere. As the major provider of warmth and light the Sun has a strong influence on our biosphere. The Moon/Earth equilibrium has also a high ranking. The meteorites from the Universe, the Milky Way and the Solar System as well as other forms of matter/energy/particles/rays and the forms/powers/systems not yet known to us humans have influenced and will influence our biosphere. Fortunately, their impacts are not so frequent.

The planet Earth's attributes studied by physics/geography/biology have a most important position. Due to permanent evolvement, interactions, interdependences, co-operation, etc., the powers of nature have created our biosphere, and keep creating it. We humans can see its past and present. We can understand dynamics of some of the mentioned systems/powers, but not of all of them. Our knowledge at present is lacking system thinking, as a possibility to better understand the system inter/dependencies and dynamics.

The inner core of the Earth has some 1.500 miles in diameter and is moving like a top with a different speed as other parts of the planet do. Any change in the revolutions and directions of the movements could have a strong impact on the Earth system. More research is needed, to understand this subsystem, and its interdependences, interactions and co-operations with other subsystems.

The rest of the Earth – outer core, lower mantle, upper mantle and crust totaling some 3.200 – 3.250 miles in diameter have a number of common interactions, which influence the biosphere. Earth's permanent changing under its surface is broken into numerous crust plates, which are in constant motion with respect to each other because of the powerful internal forces. Volcanic activities and earthquakes are products of large-scale crust plate collisions or separations. Both activities have complex impact on our biosphere, from the local direct disastrous impacts by lava, ashes and land movements, to the even tougher impacts in cases of strong eruptions and large inputs of ashes into our atmosphere. They result in impacts on the biosphere as a whole.

The natural powers such as gravitation, magnetic force, electricity, etc., circular movements like a top and joint movement within the space of the Solar System, the Milky Way, and the Universe are extremely important and not yet fully understood by our civilization, as well as the particles movements and system abilities.

The climate change system – the provider/maker/guardian and holder of living conditions within our biosphere, have been composed of a large number of systems, which interact, and are interdependent/co-operate and evolve into the present condition at the place of observation, all at same time. Thinking globally, the climate change system could be observed in some of patterns or expressions or variations, which show up in different values of the temperature, moisture, and currents.

The biosphere is composed of terrestrial, aquatic and atmospheric subsystems. Their characteristics are basically the frames, within which the climate change system has the role of the provider, maker, holder and guardian of living conditions.

Very well known geographical facts of the Earth, such as latitude, longitude, and altitude are qualities decisive for warmth and light, which are reflected in the quality of local environment. On the other hand the distribution of this quality depends on the basic characteristic of land or aquatic environment. Of course when differences meet, at bordering environments, their quality is more complex. And it is not so simple, when taking into account complex interdependences/interaction/co-operation of all different systems together, which have something to do with the climate change system.

From the selected viewpoint, the most important inferior system of our biosphere is life on the planet Earth. As soon as the primordial Earth was ready to host life, it appeared. In ocean waters the anaerobic bacterial life was the first to influence all later evolvements. Due to the exceptional reaches of ocean waters full of inorganic compounds the first bacterial cells had an excellent living environ-

ment. The ocean waters protected them from UV rays and the temperature of waters was suitable. The light and warmth from the Sun were at a lower radiation as today. All phases of the anaerobic life lasted from its commencement on from around 3.8 billions years ago until the appearance of oxygen in the atmosphere around 2 billions years ago. The bacteria have changed the Earth's biosphere from an oxygen-free to an oxygen-rich one, from an environment unprotected against UV rays, to environment with ozone layer as UV protection zone. Sterile terrestrial lands changed to lands rich with life. After the change from the anaerobic to the aerobic life the biosphere changed, and many complex life forms evolved. The water cycle, the oxygen cycles, the carbon dioxide cycles, the sulfur cycle, and waste of organic compounds together with life itself have been an integral part of the biosphere's environment. The basic influence was transferring of the fragile environments into life-friendly environments, and resulted in protection of the Earth surface against erosion and consequences such as destruction of lands, ocean water currents, and air movements that have been established as regular or temporary. The biosphere was evolving and became the space for life and living creature. Physical, geographical, chemical, biological and systemic interdependences/interactions and co-operation provided a possibility for an environment supportive of evolvement of life. Today, we may find at the same time within the Earth biosphere primordial conditions as well as any later evolvements, which followed them in time. Our present biosphere has a countless number of biological sub-systems, which are along with their synergies, ensuring the life continuity in the present and many other possible and changed environments.

The terrestrial lands, from the frozen Arctic/Antarctic environments to the tropic conditions, are home of a large number of different living creatures systems, which all together make a comfortable living as long as they follow the system interdependence/interactions and co-operation. All ethological differences are a part of the maintenance of environmental matter exchange, in which numberless biosphere sub-systems evolved for the life to continue. The changes/evolvements are consequences of interdependences/interactions and co-operation of all systems involved. The same apply to the evolvement of the aquatic and atmospheric environments. **The biological system is a moderator of living conditions within the biosphere.**

The Sun is energy – light and warmth provider. The planet Earth protection systems are ozone protection zone in the Stratosphere (15–24 kilometers) and the green house effect (the natural parts of which are carbon dioxide, methane and nitrogen oxide). Both protection systems are filtering/transporting radian energy to the surface of the Earth and back to the outer space. The geography of the Earth at present as surface has around 30% of terrestrial and 70% of water areas

(oceans/seas). The energy equilibrium is a result of inputs and outputs of energy. Changes within inputs and outputs are interfering with energy balance, and their consequences are cooling or warming. But due to the complex system characteristics of the Earth such as: changes in the atmosphere, changes at the terrestrial part, changes at the oceans/seas waters, changes within the biology of the surface, and anthropogenic inputs, the reaction of warming or cooling has different patterns. The air movements and oceans/seas currents have an additional influence adding to this complexity.

The energy balance is a most important life supporting system, and the changes within it are very destructive for the biology of our biosphere. Changes result in extinctions of animals, plants and bacteria, and appearances of new forms of the life. Drastic changes are known as glacier or ice periods; in the past the Earth experienced a number of them.

3. The Water Circle – a Crucial Component of the Climate Change System

The water circle makes the difference between Planet Earth and the other terrestrial planets Mars, Venus, and Mercury. It is a part of the biosphere and has been provided at the birth of the Earth. The water cycle is a sub-system of the biosphere, which provides the basis of quantity/quality of the biosphere environment. After birth of the Earth, as soon as it had become cool enough, water appeared in liquid, ice, and gas forms; the water cycle commenced its permanent action or evolvements.

As an environment it has excellent transport and interaction abilities, which probably together with other sub-systems: cloud formation and movements, lightening and natural electricity, assisted the birth of life. Life appeared in aquatic environment, and it took almost two billions years for life to move from the aquatic environment into terrestrial lands. 97.5% of the Earth water is there in oceans/seas, and fresh water 2.5% are: 68.7% in glaciers (which are diminishing due to the climate change system impact to main surface temperature), underground waters 30.1%, permafrost 0.8% (also decreasing), and surface and atmosphere waters 0.4%. Surface and atmospheric waters are: lakes 67.4%, top soil moisture 12.2%, atmospheric waters 9.5%, swamps/marsh lands 8.5%, rivers and streams 1.6% and biota waters in living creatures 0.8%.

Yet the water is a needed quality of biosphere, which has been a precondition for life. Most living creatures have between 75 and 95% and more of water content within their bodies. The water is the main transport system within cells, tissues and body itself. The water is the main environment for chemical processes in nature.

The water is the main architect of nature, when carving mountains, lakes, rivers, and shaping the Earth surface.

Water movements/currents of oceans and seas result from the temperature and salinity difference, trade winds and interdependences/interactions and co--operation of other Earth systems – gravitation, Earth movement, air movement, energy balance, Moon and Sun gravitation, etc. Present status of oceans currents has important role within the climate change system. The change within them may have dramatic consequences to all other parts of Biosphere. Tsunami catastrophic disaster during end of 2004 has demonstrated power of the Nature.

Air and water are permanently interdependent, interacting and co-operating when the water changes from liquid to water vapor, which is transportable by air. When temperature changes in the processes, assisted by the air particles (physical or biological), the water vapor changes into ice and liquid form and comes down to the surface as precipitation.

The mountains are water towers of the terrestrial surface, and the forest is the primary filter of water and its transporter to the underground. Rivers take water to lower altitudes and with their biological system they are secondary filters/conditioners of water. The river waters are the main transporter of mineral components from mountains and higher altitudes to lower altitudes and finally to the seas.

When waters from higher altitudes do not find their way to lower altitudes, lakes show up, and with their biological life they form the lake waters systems. Of course, lakes can have river water input and river water output, but the lake water body is placed under the level of water outtake. Lakes are the water storages at higher altitudes.

Swamps, swamp-forests and marsh land areas are best biological filters of water, and they usually are placed at lower altitudes and as estuaries. At all locations where water (fresh or salty) and land meet there are the biologically richest regions. The planet Earth matter exchange is possible due to water's active transporter role, and the activity of environment with biological richness, which helps our health by purifying the terrestrial surface waters.

The underground waters transport water under the Earth's surface and provide water in water springs. There are large underground waters at deeper levels of terrestrial and ocean/seas bottom levels, which are there because of the Earth crust movements. They are underground lakes of waters rich with minerals and usually sterile.

The terrestrial surface water movement result for both the altitude and gravitation, and water has the golden ability to move downward (gravitation), and it has a leveled surface when staying. The terrestrial, biological and atmospheric waters are less than one percent of total waters on the Earth, but due to water circle they are an important sub-system of the biosphere.

4. The Atmosphere as Another Crucial Part of the Climate Change System

Between the Earth body and outer space reaching up to 1.000 kilometers there is a large environment of gasses, rays, particles, nature powers and forces called atmosphere. The first ten to fifteen kilometers is the troposphere, the lower part of the atmosphere. It is the weather-impacting region where the air movement is most frequent. It is here that clouds form and move and one can find living creatures, from birds to microbial life forms. Troposphere ends into stratosphere reaching 15–50 kilometers from the Earth's surface, including the ozone protection band (15–24 kilometers). Mesosphere (50–85 kilometers) and Thermosphere (85–400 kilometers) end into exosphere, which ends into outer space at the altitude of around 1.000 kilometers. The atmosphere is a gaseous cover of the Earth surface and it is an integral part of the biosphere and of the whole Planet Earth System. It takes, transports, rebounds, transforms the band of the Earth for the Sun's rays of light and warmth, as well as for any rays/particles/outer space bodies/nature powers meeting the Earth as a whole.

Two main gases make 99% of the atmosphere: nitrogen 78%, and oxygen 21%. As everything in the nature their distribution, movement, and content change within limited possibilities. The remaining one percent is made of the natural presence of carbon dioxide, methane, water vapor, nitrogen oxides, argon etc. The oxygen is present as dioxide, ozone, carbon dioxide, and water vapor. As a contribution from our civilization additional contents of gases have been put into atmosphere such as: additional carbon dioxide, additional methane, nitrous oxide, chlorofluorocarbons CFCs, hydro fluorocarbons HFCs, per fluorinated carbons PFCs as green house gases. As photo chemically important gases there are carbon monoxide, oxides of nitrogen and non-methane volatile organic compounds NMVOCs, which indirectly contribute to the green house effect.

The atmosphere as the largest part of biosphere has an important role of making life possible due to oxygen concentration, which is the life-supporting gas amongst the atmosphere gases. Secondly it is the area of water vapor transport, cloud formation, and the main transporter of the water circle, important from the biology point of view. The air movement in the multidimensional space has regular and irregular patterns, and at present during the climate change system movement the extreme air movements are recorded. The wind speed last 20 years has been recorded up to around 500 + kilometers per hour. For the biosphere, the air movement is of great importance as a transporter of life forms, moisture supplier, and local weather maker. On the other hand it is antagonistic to the human constructions, which are usually demolished, if they are constructed at lower standards of the wind/tornado/typhoon strength, when it occurs.

The carbon cycle was probably the most important cycle during the primordial Earth times, because it caused the crust formation and carbon circle deposition at ocean/seas bottom and land surface. It is a direct in/output of biology, and partly of the biosphere chemistry processes.

Carbon is a constructing element of the biosphere. A very fast (less than 1 year) exchange of carbon is within plant life. It is today the second carbon exchange, which takes the first place when thinking of the very fast carbon exchange. Fast (1–10 years) carbon exchange comes from soil and oceans/seas surface. Slow (10–100 years) is exchange of carbon within the forest systems. Very slow (more than 100 yeas) carbon exchange is important in the biosphere as deposition of carbon by microbial life and Calcium carbonate sediments/rocks. Due to the relatively slow processes within the carbon cycle in nature, and the relatively fast input of carbon from our civilization into our biosphere, we have a situation, which the existing processes in the biosphere are not able to compensate. It is one of the reasons for the global warming.

The sulphur cycle has been a less important cycle in the nature during the time when our civilization did not exist. It has its important role within nature, but our civilization causes damages in nature by increased quantities of sulphur (acid rain) that became fast a damaging factor. The sulphur is an essential element for the life to exist on the Earth.

References

System Thinking and Climate Change System, Ecimovic/Mulej/Mayur, 2002, *Our Common Enemy (The Climate Change Threat)*, 2006, *The Information Theory of Nature, and.....*, 2006, and *Sustainable (Development) Future of Mankind* published on 30th September 2007, all displayed at: www.institut-climatechange.si.

List of books, articles, presentations, which have been used, has more than 200 titles and could be seen at: *The Sustainable (Development) Future of Mankind*, Ecimovic *et al.* 2007, pages 154–185, and the book is displayed at: www.institut-climatechange.si.