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The Importance of Integrating Nature into Our Artificial Systems

Introduction

"The mere formulation of a problem is far more essential than its solution, which may be merely a matter of mathematical or experimental skills. To raise new questions, new possibilities, to regard old problems from a new angle require creative imagination and marks real advances in science."

Albert Einstein

As we continue to manage our artificial systems, it is important for us to remember this statement because it summarizes our current situation rather perfectly – even after all these years, we're still confused, and we have never learned or understood what the actual problem *is*. This paper will provide a unique perspective and hypothesis to describe: the starting point and the *common denominator* of the problem; how this *common denominator* correlates to the continual degradation and/or eventual break-down in the vast majority of our artificial systems; and how the re-integration of this *common denominator* can be applied to restore and/or enhance the overall performance and sustainability to these systems.

Paradigm Shifts

When we consider that problems can only be solved when their *root causes* become known, our ongoing difficulties with so many of our artificial systems should not be viewed as a mere coincidence; we must realize that we could also have misinterpreted the entire problem all along. As human beings, our personal biases will often prejudice our ability to think clearly with an open mind, and cause us to pre-conceive the form and manner in which we think the solution should be like.

Instead of relying on the same old conventional wisdom and paradigm – which is, as it pertains to this subject, the most popular and prevailing way world academia *thinks, interprets, and perceive*s earth and how its natural processes function – we need to question and reevaluate its validity by becoming more acquainted with specific aspects about the earth that we seem to have overlooked and missed. After all, it may have some inaccuracies and flaws, and who's to say that this is the only foundation there is to formulate and base our solutions on.

The old paradigm

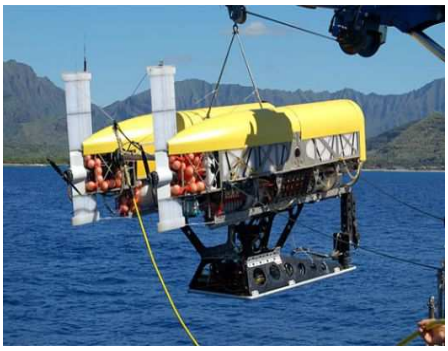
Most of the informational data we have amassed and learned so far about the earth has been derived from accessible areas only, which pertains to things gathered at or slightly below the surface, or above our planet. Furthermore, given that: nearly 75% of our planet is covered and underneath the ocean and we have charted and mapped less than 1% of the ocean floor; we have never gained access into earth's inner core; and our deepest penetration we have ever made (12,262 meters) still represents a fraction of the earth's outer crust, etc., we must humbly acknowledge that our entire base of knowledge and everything that we think and perceive to know about this planet remains extremely limited and skewed.

Planet Earth
NASA Goddard Space
Flight Center Image

As a result of this imbalance, there is a high probability that many of the solutions we have already adopted or are about to implement may be – because they were based using our old paradigm – flawed as well. We just haven't realized it yet. This doesn't mean we should abandon everything that we have learned so far, it just means that we need more information from specific areas in order to provide the balance we need to properly discern what is true from the things that are not. Doing so will help us to formulate better and more accurate solutions in our quest to advance humanity.

The new paradigm

The inability to overcome the extreme depth and pressure at the bottom of the oceans has kept this region of the earth virtually hidden from us for centuries. The danger and cost have simply been too great for manned exploration. However, with the recent advent of unmanned submersible hybrid remote operated vehicles (HROV), digitized video images and other information can now be transmitted in real time to scientists all over the world, and physical samples can be gathered for analysis. The need to obtain this information by manned submersibles is no longer necessary. Some of this new information has already revealed things about the earth that we never knew before – because they were out of sight and out of mind.



Nereus Hybrid Remote Operated Vehicle
Woods Hole Oceanographic Institution

More importantly, this has revealed and reconfirmed to us what the *common denominator* that is behind earth's natural process, how it functions, and why our planet is the way it is. As we continue throughout this new age of oceanic exploration, the new information we receive will dispel the myths within our old paradigm, and start to shift us towards the adoption of a newer and more accurate one.

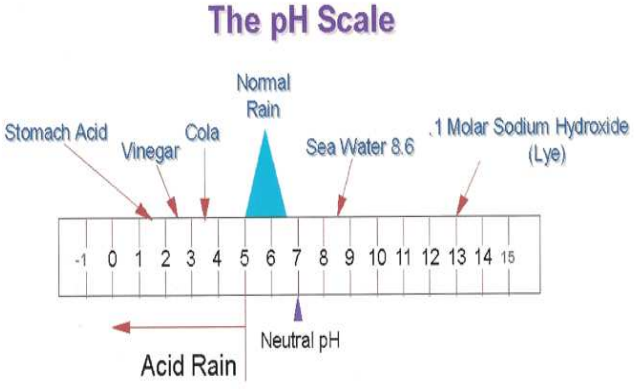
Rediscovering the common denominator

Chilean Chaiten Volcano Jan. 2009

Kilauea Volcanic Fumarole

Alaska Mt. Redoubt Mar. 2009

There are about five hundred and ninety volcanoes on the surface of the earth that are known to exist. Based on records from the past 30 years, an average of sixty volcanoes have been confirmed to be active simultaneously. As these volcanoes erupt, they spew and emit into the atmosphere large amounts of sulfur dioxide (SO_2). This gas, because of its natural affinity to bond with water, helps to coalesce water vapor into raindrops containing sulfurous acid ($S + O_2 \rightarrow SO_2 + H_2O \rightarrow H_2SO_3$), and causes rain to have a normal pH average of 5.6 throughout the world. The manner in which nature naturally acidifies rainwater to this very day still remains largely overlooked, and the normality of this pH level as it free falls from the sky is often misperceived by many to be the direct result of human caused pollution such as coal burning, instead of being a common function of the earth's natural process.



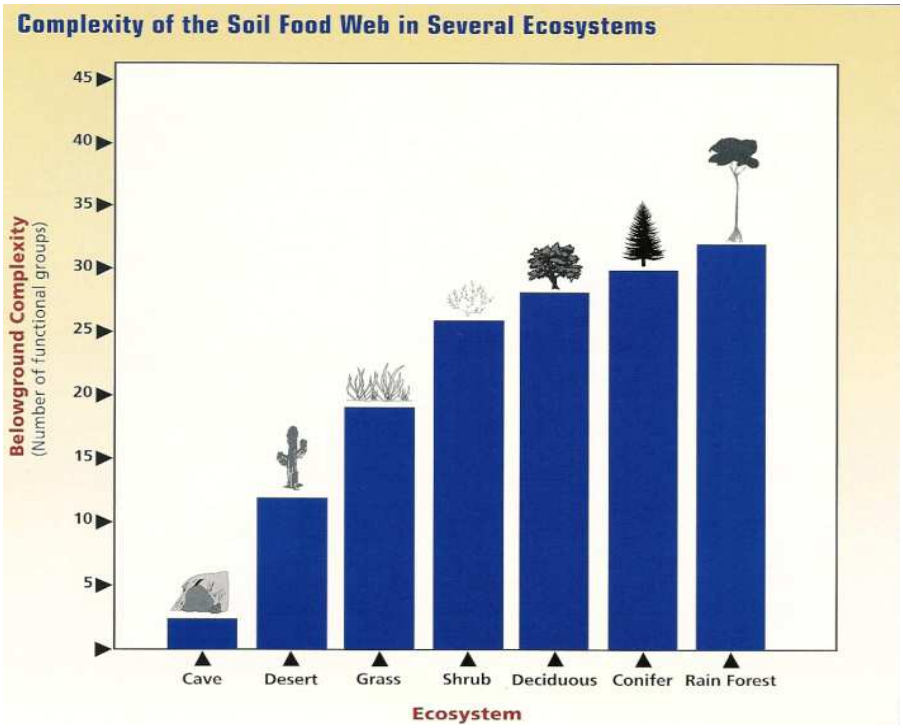
http://www.ems.psu/info/explore/acidr/phscale.gif

While it is important for us to look for ways to minimize pollution and to protect the environment, it is equally important that we avoid becoming confused as to how earth's natural process actually works. This is because in order to become fully compatible and sustainable with nature, we must try to find as many ways as we can to reintroduce and integrate nature back into our artificial systems whenever possible. This will require us to be able to mimic it. And, we certainly can't do that if we continue to misinterpret it and believe in myths.

Coal Burning Power plant

Volcanic emissions of sulfur dioxide (SO^2), and its ensuing reaction with atmospheric water vapor and seawater, offers perhaps the most persuasive explanation as to why the element of hydrogen (H^+), or acidity, is, and has always been, the real *common denominator* behind earth's ecosystems and how they actually came to be.

When we analyze the various ecosystems that exist on the surface of the earth, more often than not, we automatically make the assumption that the most distinguishing feature and what sets them apart is the aggregate amount of water they receive. After all, it does seem to correlate and make sense. However, as we examine deeper, in the end, we will ultimately conclude that this assumption may not be true after all.



Ingham, Elaine R., 2000. Soil Biology Primer

Because, while water is indeed important, it's not the volume or amount of water that really drives and creates these ecosystems, it's the total aggregate amount of free hydrogen ions (H^+), or acidity, that an ecosystem receives that makes them different. Rainwater is just the medium that carries and delivers it. Logic dictates that this must be so because, if normal rainwater was truly neutral in pH, and had no acidifying component within it, it wouldn't be able to dissolve or breakdown rocks and minerals into soil. We can only imagine how much longer it would have taken to create these surface ecosystems.

Recent discoveries of undersea volcanoes and hydrothermal vents reveal that this same acidifying process must also be taking place on the ocean floor as well. Although the actual sum total has yet to be determined, current observations appear to indicate that the number and overall volume of emissions from these underwater sources are far more numerous, occur with a much greater intensity and duration than we

Black Smoker Vent, Juan de Fuca Ridge, North American Plate, off CA OR WA coast NOAA

Hydrothermal vent Nikko caldera, Mariana Arc, South Pacific Submarine Ring of Fire NOAA

have ever thought or imagined, in comparison with those on the surface. The chemical reaction illustrated below explains how nature converts elemental sulfur into sulfur dioxide (SO^2) to break apart molecular bonds of water to release two free and active hydrogen ions ($2\ H^+$) to create acidity.

$$S + O_2 \rightarrow SO_2 + H_2O \rightarrow H_2SO_3 \rightarrow H^+ + HSO_3^- + O_2 \rightarrow H^+ + SO_4^=$$

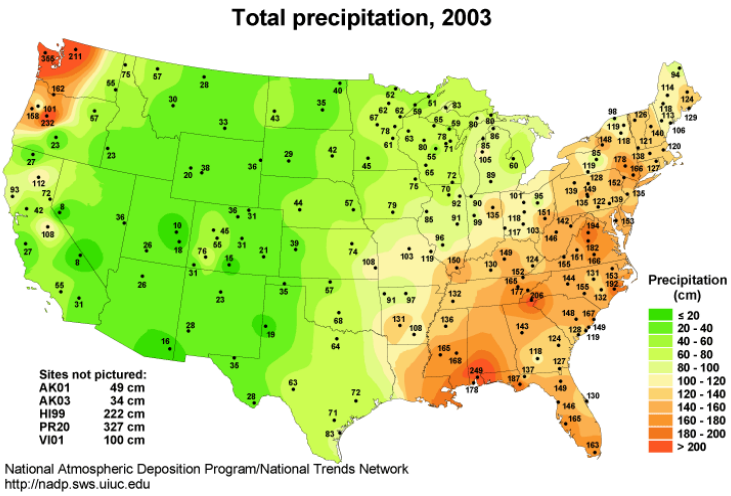
Sulfur + Oxygen yields Sulfur Dioxide + Water yields Sulfurous Acid yields Hydrogen + Bisulfite + Oxygen yields Hydrogen + Sulfate

As this acidity becomes available, nature then utilizes these two hydrogen ions ($2\ H^+$) to neutralize and transform the Total Alkalinity, which is measured as bicarbonates (HCO_3^-) and carbonates (CO_3), within seawater into pure water (H_2O), carbon dioxide (CO_2), and sulfate ($SO_4^=$).

$$H_2SO_3 + HCO_3^- \rightarrow H_2CO_3 + HSO_3^- \rightarrow H_2O + CO_2\uparrow + HSO_3^- + O_2 \rightarrow H^+ + SO_4^=$$

Sulfurous Acid + Bicarbonate yields Carbonic Acid + Bisulfite yields Water + Carbon Dioxide + Bisulfite + Oxygen & Thiobacillus yields Acid + Sulfate

The acidity within rainwater also illustrates why land mass areas that receive high amounts of rainfall generally develop into acidic soils and why semi-arid and arid areas continue to remain alkaline. In addition, because the acidity within rainwater essentially dissolves salt carbonates within soil, which creates more soil pore space and keeps them open, salts are able to leach away from the root zone, and it allows both oxygen and carbon dioxide to penetrate and exchange past the soil/air interface and deeper throughout the soil profile. The ability to continuously receive a sufficient amount of acidity over time provides the most plausible reason why, in high rainfall regions, soil salinity issues are rare. And it explains why they have a much higher microbial population density and are able to sequester more soil organic carbon compared to low precipitation areas.



Precipitated salt carbonates near Bonneville, Utah

The planet Mars and its surface

The natural process of volcanoes creating and using acidity to transform the Total Alkalinity within seawater into pure water and carbon dioxide may also be the most compelling reason why: the oceans of the earth are still able to remain diluted and have not precipitated out of solution; this planet has and continues to have an atmosphere and is able to support life; etc. When we consider what has already happened to inland seas that receive very little acidity from rainfall or volcanic activity, this may not be so far fetched as it seems. Could this be the actual reason why Mars no longer has an ocean, has salt carbonates on the surface, and has no atmosphere? And what would happen to this planet if the total level of volcanic activity began fluctuating and/or if it completely stopped, could this happen here as well?

The correlation of sulfur, free hydrogen, and alkalinity is clearly evident, and we must remember to factor in the relationship between these components as we interpret earth's natural process, advance the issue of sustainability and the way we use natural resources, and approach subjects such as global warming and climate change.

The formula below illustrates how salt cations such as calcium bonds with bicarbonate anions to precipitate out of solution. Other possible combinations include: sodium; potassium; magnesium; chloride; etc.

Ca	+	$(HCO_3^-)_2$	→	$CaCO_3$	+	H_2O	+	$CO_2\uparrow$
Calcium	+	Bicarbonate	yields	Calcium Carbonate	+	Water	+	Carbon Dioxide

The importance of integrating nature into our artificial systems

The process of creating enough free hydrogen to control the level of bicarbonates/carbonates applies to our artificial systems as well. Because whether the problem is: soil salinity on farmland; mineral scaling on reverse osmosis filtration membranes, cooling towers and boilers; or finding a better and more sustainable way to process and utilize waste water; etc., the operational success or failure of these systems will be determined primarily by our ability to adequately supply and regulate the proper amount of free hydrogen within them.


Soil Salinity


Reverse Osmosis Filtration


Cooling Towers


Wastewater Treatment

One such way is to use a special type of equipment known generically as a SO_2/Sulfurous Acid Generator/Sulfur Burner. Unlike the methods that basically acidify by "importing and bringing in" hydrogen from outside of system (the way strong acids like sulfuric acid do), this technique acts like a "miniature volcano" to artificially condition the water so that it releases free and active hydrogen within itself, which allows all of the acidity needed for pH control to be synthetically made entirely on-site, the exact same way nature does.

Harmon SO_2/Sulfurous Acid Generator/Sulfur Burner

Since sulfurous acid is a weak acid, as it releases its first hydrogen ion (H^+), the remaining portion converts into bisulfite (HSO_3^-), a compound that can be used to: prevent bio-film from plugging reverse osmosis filtration membranes; as a reducing agent to de-chlorinate water; as an aid to help deconstruct wastewater pharmaceuticals and perchlorate. Using this process to lower the pH even further will also result in causing suspended solids to settle and molecular sulfur dioxide (SO^2) to form in solution, which enables this process to separate and disinfect both sludge and water simultaneously. The combination of these features makes this method of processing promising and worth looking into for a variety of applications.

Conclusion

The most important part in problem solving is determining what the actual problem *is*. This requires objectivity and the ability to realize the existence of a different and more accurate paradigm. By reexamining volcanic emissions of sulfur dioxide and the chemical reaction it has with water, both in the atmosphere and within the oceans, we can learn the common denominator behind earth's natural process. We can also find the root cause as to why our artificial systems deteriorate and why it is so important for us to begin re-integrating nature back into our artificial systems to make them more viable and sustainable.