Hydrosphere

The Giver of Life

Rayappa A. Kasi

An Appeal to Save Water and its Fish on Earth
United Nations International Year of Biodiversity 2010
Year of Priests 2009 - 2010

LTD – Media Publications
Chennai - India

Address:
Rayappa A. Kasi,
A. Kattupadi,
Vellore - 632011.

Other Publications from the Author:

1. Earth-The Lost Paradise of Happiness, 2009.
2. Global Warming - Everything you want to know! 2010.
3. Biosphere – The Fragility of Our Natural Heritage, 2010
4. Lithosphere – A Destructive Creator

Hydrosphere – The Giver of Life

Published by LTD Media
C4. Velan Appartment, 4th Street
Railway Colony, Nelson Manickem Road, Chennai – 600 029

Printed at:
Saravana Graphics, Aayiram Vilakku, Chennai – 600 006
Cover Page Designed by Rayappa A. Kasi
Picture on the Cover: Humpback Whale in Alaska
Price: Rs.80/-

Content

Preface	5
Year of Priests 2009-2010: An Appeal to Save Water and its Life on Earth	11
Water the Creator – The Day the Rains Came!	17
Water the Destroyer – The Day the Floods Came	19
The Fabric of Water	21
Origin of Water	22
The Beginning of Life on Earth	26
Life Dependence on Water	27
Importance and Use of Water	29
Sweet Fresh Water	32
The Great Arteries – The Rivers	34
The Blood of the Earth – The Power of Water	37
Water and Climate	42
Formation of Clouds	43
The Circulatory System	44
Lakes – Our Blue Little Worlds	46
Deep Blue Oceans and Seas – Terra Incognita	48
Four Major Oceans	49
Characteristics of Oceans and Seas	52
Corals and Atolls	55
The Coral Ecosystem	57
The Cycle of Oceans and Seas	59
Formation of Ice Sheets	60
Cryosphere – The Frozen Earth	63
Water, Industry and Pollution – The Precariousness of Hydrosphere	65

Seven Mega Disasters of Hydrosphere

1. The Land of Mu or Lemuria – Disaster Number One	67
2. The Lost Civilization of Atlantis – Disaster Number Two	70

3. The Dead Sea – Disaster Number Three 71
4. Titanic – Disaster Number Four 72
5. Coovam, Chennai, India – Disaster Number Five 76
6. Over-Fishing – Disaster Number Six 77
7. The Devil's Triangle – Disaster Number Seven 79

Seven Wonders of Hydrosphere

1. Baptism: The Giver of New Life – First Wonder of Hydrosphere 82
2. Angel Falls, Venezuela – Second Wonder of Biosphere 83
3. River Nile – Third Wonder of Hydrosphere 84
4. Lake Tanganyika – Fifth Wonder of Hydrosphere 85
5. Trenches and Ridges – Fifth Wonder of Hydrosphere 86
6. The Gulf Stream: Atlantic Ocean – Sixth Wonder of Hydrosphere 87
7. Iguazu Waterfalls: Brazil – Seventh Wonder of Hydrosphere 88

Ten Heroes of Hydrosphere

1. Rain – Hero Number One of Hydrosphere 89
2. Building Blocks of Life – Hero Number Two of Hydrosphere 91
3. Water Molecule – Hero Number Three of Hydrosphere 92
4. Transpiration – Hero Number Four of Hydrosphere 93
5. Osmosis – Hero Number Five of Hydrosphere 94
6. Aquifers – Hero Number Six of Hydrosphere 95
7. Hydrothermal Vents – Hero Number Seven of Hydrosphere 96
8. Amino Acids – Hero Number Eight of Hydrosphere 97
9. Thermohaline Circulation – Hero Number Nine of Hydrosphere 99
10. Water Erosion – Hero Number Ten of Hydrosphere 100

The Ten Commandments of Hydrosphere 101
Finally … 102
Bibliography 103

Preface

Human beings are an infant species, appearing in the last 0.001 percent of the time that life has existed on Earth. For most of the 150,000 years of our species' existence, we were hunters-gatherers, carrying all our possessions in a constant search for food and water. Even after the agricultural revolution ten millennia ago, we lived within limited confines in the company of a few dozen people. We have been local, tribal animals for almost all our time on Earth. But suddenly we have become a geological force, altering the physical, chemical, and biological makeup of the planet as no other species has ever done. We have embraced the benefits of our newly acquired powers with little regard for the consequences within the Biosphere. But now we have to ask, "What is the collective impact of all 7 billion human beings?"—and it is very difficult to assess. *Today, we are the most numerous mammals on Earth, and our huge ecological footprint has been amplified beyond that of any other species by our technological muscle power, voracious appetite, and global economy*.

Over population certainly puts pressure on food and water resources and it appears that humanity will soon face a big problem for: water. Earth is the water planet, and water, in its three states—vapor, liquid, and solid—defines and sustains Earth. The principal part of its liquid state forms the oceans, which cover 70% of Earth's surface. Solid water, mostly in the form of glacial ice, covers a further 10.4%. Water is essential to life because the various electrochemical processes that constitute humans and other life forms can occur only within it. *The ocean was almost certainly the cradle of life, and it remains life's most expansive habitat.* The volume of the oceans—about 520 million cubic kilometers—is eleven times larger than all the land above the sea. And whereas land is populated by life only at its surface, the entire volume of the oceans is capable of sustaining life.

If the movement of the plate tectonics is important to life on land, it is absolutely vital to life in the sea. The waters of the oceans are recycled, through evaporation and precipitation, through Earth's rivers every 30,000 to 40,000 years, and with each recycling, rivers leach salt from the rocks, which is carried into the sea. You might deduce from this that the oceans are growing saltier. Earth's oceans have maintained a relatively steady level of saltiness for billions of years, and they do so thanks to the mid ocean ridges, where Earth's plates are pulled apart, allowing the ocean basins to grow. As the oceanic crust pulls apart, magma comes to the surface and the ocean penetrates this new, hot rock.

Hydrothermal vents form, and through these eventually all of the ocean water in the world circulates. It takes 10 million to 100 million years for all the water in the ocean to pass through the hydrothermal vents, but as it does so the chemical structure of the seawater is altered by the extreme heat, and salt is removed. It is a remarkable thought that all this is made possible by the continents and their movement. This recycling of the oceans keeps the saltiness of the sea constant, that life itself may have helped created.

We know the sea is the birthplace of all terrestrial life. But we are just learning that it is also our lifeblood, that the planet's deep volcanic heartbeat renews and circulates the sea and helps make this a living planet rather than a dead one. In a remarkable twist of geo-poetry, we may ultimately learn that the Earth's heartbeat gave rise to our own. Earth is a one huge, lush water-world. Water is a mysterious substance. Oceans are very mysterious, keeping secrets of the hidden worlds, with their alien creatures, living fossils, lost treasures, precious metals, and perhaps even the place where life itself first arose billions of years ago. *Oceans contain not only great mysteries and riches but great dangers as well, including the deadly radioactive debris of the cold war. Thousands of bombs, nuclear reactors, and warheads still lie scattered throughout the deep ocean floor.*

Deep pollution, mining, and fishing threaten this frontier with ecological upset and species extinction. Action is called for, but action motivated by guilt may only compound the problem. We are in disharmony with the world because we are in disharmony with ourselves. *Guilt is an indication of this. Guilt is a warning that there is an incongruity in our value system, a schism in our sense of self that needs to be investigated.* If we act without introspection, we simply throw our weight to one side of the inner conflict, increasing the disharmony. Our actions will be incomplete and fragmented. We will make some token move and fall back into denial and minimization. To heal is to make whole.

Astronomer Carl Sagan called Earth *"a pale blue dot."* The image that moved Carl Sagan to such poetic magnificence was taken by spacecraft Voyager I on 14 February 1990. The vessel was 4 billion miles from home—a mile for every year of EARTH's existence—when it captured that image, and in it earth is nothing more than a minute blue dot, all but lost in the immensity of the cosmos. Carl Sagan wrote, *"We succeeded in taking that picture, and if you look at it, you see a dot. That's here. That's home. That's us. On it, everyone you ever heard of, every human being who ever lived—lived out their lives. The aggregate of all our joys and sufferings, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every* *creator and destroyer of civilizations, every king and peasant, every young couple in love, every hopeful child, every mother and father, every inventor and explorer, every teacher of morals, every corrupt politician, every superstar, every supreme leader, every saint and sinner in the history of our species, lived there on a mote of dust, suspended in a sunbeam."*

With the twenty-first century nearly a decade old, Sagan's description resonates more powerfully than ever. Our despoliation of Earth's life–support systems seems to mark us as the destroyer of our own civilizations; and as the planetary crisis we have created deepens, *it is certain that no savior will ride across the cosmos to rescue us from ourselves.* The most credible estimates indicate that we are already exceeding Earth's capacity to support our species by about 25%. With global fresh water and global food security at an all-time low, and greenhouse gases so choking our atmosphere as to threaten a global climatic catastrophe, the signs of what may come are all around us. Just consider the phenomenon of life. The majority of the living things on this planet dwell in the sea. Yet we know little about their representatives in the un-illuminated depths, an area that makes up the vast preponderance of the Biosphere. *The oceans are the most important means by which carbon is drawn from the atmosphere.*

Indeed, when considered on a timescale of centuries, historically they have been the only carbon sink that counts. And today, with more carbon in the air, these sinks have much more to absorb. Some of the carbon absorbed by the ocean is used by algae, and some remains dissolved in the water, where it forms carbolic acid. Some of the carbon taken in by algae falls to the ocean floor when the algae die and sink, and there it is destined to form carbonate rock, thereby removing the carbon more or less permanently from the atmosphere. *The carbolic acid that remains in the water, however, is very different. As it builds up, it causes the ocean to acidify; and acidity damages life, including the algae that sequester the carbon. Ocean acidification is a much more urgent threat than we previously thought and it is most advanced in the North Pacific Ocean.*

The North Pacific Ocean is so full of life that it seems like a fantasyland. The average temperature of these waters is a mere 3 degrees Celsius, which is good thing indeed for life, as frigid water is full of oxygen and so can support life in the oceans from bottom to top. But, increasing CO2 in the atmosphere has already caused damage to the organisms in the oceans. Scientists are warning that in just a few decades, creatures living in the far north Pacific may be unable to lay down skeletons even at the surface and this would mean an end to all those oysters, mussels, crabs, and lobsters that this fecund ocean yields. Indeed, ultimately it will probably mean an end to the whales and seabirds as well, for without krill, what will they feed upon? And in time, if the problem persists, all the world's oceans will suffer the same fate. Unfortunately, Copenhagen Earth Summit did not think so. Good classical example to compare Copenhagen Summit to that of Nero fiddling when Rome was burning! We do not have any advantage of time, it's too late. We need to act and we need to act NOW!

A prudent step in the direction of ecological stewardship would be the creation of deep sanctuaries, of whole regions placed off limits to deep fishing and mining and development. The international move to coastal sanctuaries is insufficient. Given how little we know of the deep repercussions of our activities, and given the overall stakes and global pressures, it would be best to keep large parts of the wilderness as intact as possible for the sake of ourselves and future generations. Deep environmental work is vitally important yet very difficult to do, as suggested by a comparison to tropical rain forests. It is relatively easy to show that the Earth's lush jungles are under siege and that their residents are going extinct at an alarming rate. But what is of the darkness below the oceans? We currently have only the sketchiest understandings of its structure and inhabitants and food chains, much less the alterations being made by deep fishing and planetary heating and the seventy thousand or so synthetic chemicals that we have managed to inject into the global environment. By any measure, our ignorance is almost as boundless as the deep.

Today, China, India, and other rapidly industrializing economies are releasing pollutants of global dimming in ever-increasing quantities. If no attempt is made to reduce the agents of global warming concurrently with such cleanups of the agents of global dimming, humanity could experience a nearly instantaneous increase in warming that might have catastrophic consequences. It is already upon us in some parts of the world. It is folly to assume that the ecological fate of the sea is bleak and inevitable. Our decisions, individual and collective, make a difference, and those decisions will grow more important in the next century as the human population of the planet swells, along with its army of developmental pressures. Already, two-thirds of the people on Earth live near an oceanic coastline, and that fraction is growing. In the whirlwind of progress, we will either destroy the sea through ignorance or save it through knowledge. And we will feel the outcome either way. Practically every day science finds new evidence that the health of the planet is intimately tied to the state of the ocean and that our own fate and that of all living things revolves around the habitability of this global commons.

I thank the librarians at the University of Massachusetts in Boston and Duke University for their dedicated labor in obtaining journals and books. I thank Fr. Paul Ring, staff, and the people of Our Lady of Grace Parish in

Pepperell, for putting up with me. For urging me forward in countless ways, I thank my friends, Fr. James Flavin, Fr. Jerry Shea, Fr. Lawrance Drennen, Fr. Paul MacDonald, Fr. Gnana Jyothi, Fr. Arulsamy, Fr. D.F. Bosco, Fr. Bhoopathy, Fr. Johnson, Fr. Sellam Augustine SDB (Tanzania), Fr. Arasu SDB (Uganda), Francine Bell, Sr. Amala FMA, Sr. Rakkini, Sr. Baby Victoria, Sr. Auxilia, and Sr. Leonie. My heartfelt gratitude is always with, Fr. Joseph, Fr. Roy Lazar, Mr. Sagayam Deva and Mrs. Josephin, and the staff at LTD Media for their extraordinary skill in arts and editing.

Rayappa A. Kasi
Kattupadi Post
Vellore – 632 011, India

24.5.2010 – Feast of Mary Help of Christians
Year of Priests – 2009-2010
United Nations Year of Biodiversity

.

Hydrosphere – The Giver of Life

In the beginning God created the heavens and the Earth. Now the Earth was formless and empty, darkness was over the surface of the deep, and the Spirit of God was hovering over the waters. (Genesis 1:1)

In the beginning there was water. Water is an enigma. It is both simple and complex. We all know that water is essential to life, making up about 80% by weight of all living things. The Hydrosphere is often called the—"water sphere" as it includes all the Earth's water found in streams, lakes, the soil, groundwater, and in the air. The Hydrosphere interacts with, and is influenced by, all the other Earth spheres. The water of the Hydrosphere is distributed among several different stores found in the other spheres. Water is held in oceans, lakes, and streams at the surface of the Earth. Water is found in vapor, liquid and solid states in the atmosphere. The biosphere serves as an interface between the spheres enabling water to move between the Hydrosphere, lithosphere and atmosphere as is accompanied by plant transpiration. The hydrologic cycle* traces the movement of water and energy between these various stores and spheres. Consider just five attributes of this amazing substance: first, water can store a lot of heat without a substantial rise in temperature, thus helping to moderate climate; second, water expands when it freezes, causing ice to float and form an insulating layer. If like other substances, water became more dense as it froze, the lakes, the rivers, and the seas would solidify from the bottom up, entombing everything in ice; third, water is highly transparent, enabling light-dependent organisms to survive at considerable depths; fourth, water molecules produce surface tension, creating as elastic "skin." This tension enables insects to scamper about on a pond, causes water to form into droplets, and contributes to the capillary effect, which helps water to hydrate the tallest plants, and; fifth, water is the most efficient solvent known. It is able to carry in solution oxygen, carbon dioxide, salts, minerals, and many other vital substances. This book is intended

*The Hydrologic Cycle or Water Cycle, is the cycling of water through Earth system. It is the continuous circulation of water in its different states such as liquid, solid and gaseous, between the oceans, the atmosphere and the Earth's surface.

to make an appeal to save water on Earth and the main agents of appeal are priests who symbolize effective leadership.

Year of Priests 2009-2010* – An Appeal to Save Water and its Life on Earth

Priests do more than just "say mass." They become agents of transformation. Called to mediate the presence of Christ in the world, priests are set apart to serve the church in every way—as reconciler, as healer, as teacher, and as friend. Remember we studied Cosmology, Ethics and Metaphysics in our seminary days! It is time to put it to the test, because the Earth is dying. Therefore we continue to serve the church as Cosmologist, ecologist and environmentalist. We've academically trained to play these roles, while we earned a degree in philosophy and theology, required ten years of our lives. Those three years of philosophy in the seminary, I always wondered—waste of time, but now I found them—very useful when I try to understand and teach about creation, stewardship, and sustainable development. Every priest has worked hard and earned the titles such as, cosmologist, ecologist, naturalist, ontologist, astrophysicist, philosopher, theologian, and moralist. *Humanity today needs to free itself from the sin of over-consumption, not by making superficial changes, but through a true moral and spiritual conversion. It needs the salvation of the Gospel so as to emerge*

*There are 400,000 Catholic priests around the world. Pope Benedict XVI inaugurated the year of priests in June 2009 and will end with the grand celebration in Rome in June 2010.

from a profound environmental and ecological crisis, one which requires deep change, beginning with consciences. Priests can be role models for sustainable development. This is a demanding and often thankless calling. It is also a calling that would be impossible without the grace we receive from the Lord—especially the grace that comes from celebrating the Eucharist.* As an icon of Christ, every one of us, despite imperfection, and weakness, is set apart for the Lord. It's not a personal decision or a career choice. It's a divine commission, a calling from God. Just as Jesus sanctified the church, priest sanctifies his people. St. Paul says: "If he is truly to be a mediator between God and man, a priest must be man." This is fundamental and the Son of God was made man precisely in order to be a priest, to be able to fulfill the priest's mission. Every priest is a man, too: but he is unable, on his own, to make himself a mediator for God. Therefore he needs to be commissioned by God. The priest needs divine authorization.

Institution, and only by belonging to both spheres, the divine and the human, can he be a mediator, can he be a "bridge." This is the priest's mission: to combine, to link these two realities that appear to be so separate, that is, the world of God far from us, often unknown to the human being and our human world. The priest's mission is to be a mediator, a bridge that connects, and thereby to bring human beings to God, to his redemption, to his true light, to his true life. Therefore, the priest must be on God's side. Only in the sacrament is the need, this prerequisite of mediation fully brought about. Only with the sacrament, this divine act that makes us priests in communion with Christ, can we accomplish our mission.

Mission of Christ encompasses hundreds of possibilities—selection of a particular one—perhaps, stems out from the need of time and place, in today's context the need has to be the environmental issues. Hence, with God's help priest can attempt impossible things with confidence. Hydrosphere is crying out loud for attention and renovation. Hydrosphere needs urgent healing and I think priests can lead their communities to see the disasters such as water pollution, water shortrtage, coastal erosion, and marine over-harvesting, that continue to threat the quality of life. Our appeal is to save water on Earth.

---

*It denotes the Catholic belief, the presence of Jesus in the form of bread and also means the celebration of the mass.

Politics and other organizations on Earth have failed humanity's hope for action in Copenhagen.* *The only option available right now is religion and indeed, religion is a powerful tool to bring out change. Priesthood is another powerful tool, too,* which is definitely powerful enough to save and redeem what has been lost and what is being threatened now in the world. If priests speak the whole parish listens, hence we could use all our authority and service, in bringing the needed awareness to people around us, bringing to their notice the alarming situation, the world is in. *If the two powerful religious or social and political forces can be combined in a mutually respectful alliance, with basic metaphysical differences put aside in the service of real-world goals, some of the greatest problems of the twenty-first century might be solved quickly. Catholic priests could help usher our world, so painfully divided today by culture and politics, into a new era of respect and mutual understanding.* In the past our understanding of environment was very shallow and one-sided. Regrettably, many of the religious leaders who have spoken about the environment have contributed to the confusion. But we are clear in our vision and ready now. I think people look up to our leadership.

Allow me to quote Pope Benedict, his message on the World Day of Peace, on 1st January 2010, *"At the beginning of this New Year, I wish to offer heartfelt greetings of peace to all Christian communities, international leaders, and people of good will throughout the world.*

*United Nations International Earth Summit on Climate Change in December 2009 ended in disappointment and despair, crushing the hope of better tomorrow, leaving Earth vulnerable.

For this XLIII World Day of Peace I have chosen the theme: If You Want to Cultivate Peace, Protect Creation. Respect for creation is of immense consequence, not least because "creation is the beginning and the foundation of all God's works," and its preservation has now become essential for the pacific coexistence of mankind. Man's inhumanity to man has given rise to numerous threats to peace and to authentic and integral human development – wars, international and regional conflicts, acts of terrorism, and violations of human rights. Yet no less troubling are the threats arising from the neglect – if not downright misuse – of the earth and the natural goods that God has given us. For this reason, it is imperative that mankind renew and strengthen "that covenant between human beings and the environment, which should mirror the creative love of God, from whom we come and towards whom we are journeying."

In my Encyclical "Caritas in Veritate" I noted that integral human development is closely linked to the obligations which flow from man's relationship with the natural environment. The environment must be seen as God's gift to all people, and the use we make of it entails a shared responsibility for all humanity, especially the poor and future generations. I also observed that whenever nature and human beings in particular, are seen merely as products of chance or an evolutionary determinism, our overall sense of responsibility wanes. On the other hand, seeing creation as God's gift to humanity helps us understand our vocation and worth as human beings. With the Psalmist, we can exclaim with wonder: "When I look at your heavens, the work of your hands, the moon and the stars which you have established; what is man that you are mindful of him, and the son of man that you care for him?" (Ps 8:4-5). Contemplating the beauty of creation inspires us to recognize the love of the Creator, that Love which "moves the sun and the other stars".

An objective shared by everyone, an indispensable condition for peace, is that of administering with justice and wisdom the natural resources of the Earth. "If You Want to Cultivate Peace, Protect Creation" is the very relevant theme to which Pope Benedict the XVI has dedicated his message for the 43rd World Day of Peace. Politics failed in Copenhagen and it is up to the religions to take up the cause. When it comes to great religions, Christianity is having a bigger human force of 2 billion, next Islam with 1.6 billion, and then Hinduism with almost billion. In Christianity with 400,000 members, priests are the front-liners who are the effective tools of any change in the society. We can no longer do without a real change of outlook which will result in new lifestyles. In reality all of us are responsible for the protection and care of the created world. Therefore, in this field too, education is fundamental: to learn to respect nature, to direct oneself ever more to build peace, beginning with far-reaching decisions on the part of individuals, families, communities and states. If we should care for the creatures that surround us, what consideration we should have for people, our brothers and sisters! What respect for human life? Respect for human life starts with the unlimited supply of sweet fresh water. Not only human life, all life depends on fresh water. On the other hand, as priests we know too well, how life struggles for this basic need—the clean fresh drinking water.

With over 1.1 billion people in the world who don't have access to clean drinking water, water-borne pathogens are a huge problem for the environment and for human health. The course of world society in the twenty-first century is likely to be substantially influenced by a single resource—drinking water. *The first* and most obvious fact is that water is an absolute necessity. First, quantities of water on planet earth suitable for drinking are extremely limited. Less than 1 percent of all water on Earth is available as groundwater and surface water suitable for human uses such as drinking and cooking. The remainder is either salt water (97 percent) or is locked up in ice (just over 2 percent). *Second,* precipitation, which replenishes groundwater and surface-water resources, does not fall evenly over the face of the Earth. Additionally, some times of the year are rainy. Other times dry. Thus, water resources are bountiful at some times and in some places, but extremely sparse in others. *Third,* for more than a *billion people in developing countries, water is scarce and frequently contaminated,* thereby posing a health risk. In these parts of the world, contaminated drinking water along with primitive (or nonexistent) sanitation systems annually result in widespread illness and millions of deaths annually. The majority of the victims are children.

Moreover, competition for water for domestic, industrial, and agricultural needs can only be expected to accelerate in the years ahead. Increasing urbanization and development compete with non-urban uses such as agriculture; often, these very different land and water uses adjoin one other geographically. Lawmakers and resource planners worldwide face a daunting challenge to meet ever-increasing needs for adequate drinking-water supplies. The situation is worse in less developed countries. A water-supply infrastructure often does not exist. International assistance may provide a community well; but in many cases, people drink dirty and contaminated water because no other options are available in their communities. People typically gather water from the nearest source, which often is the same one used for bathing and washing activities, waste disposal, and perhaps even watering source for local livestock. These varied uses of the same water source frequently lead to the spread of diseases. *More than 1 billion of the world's people lack access to safe water, and nearly 2 billion people lack safe sanitation. Over 3 million people annually die from avoidable water-related diseases.* Dirty water from unsanitary conditions is the leading cause of death of children in Asia, especially in India. And globally claims the life of one child every 30 seconds.

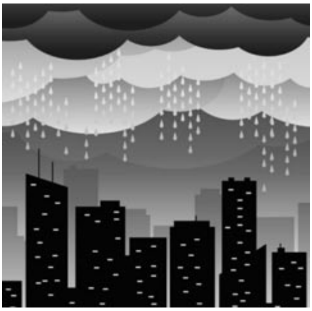
The search for water is a daily way of life for many people in developing countries, especially in most countries of the African continent, and numerous areas within Asia and south and Central America. A 2008 report by the Asian development Bank stated that of the 500 million people living in the Asia-Pacific region, one person out of three have no access to sources of safe drinking water within 200 meters of their homes. Whether in cold or hot climates, the constant search for safe drinking water is often difficult and time consuming. This situation can worsen during droughts (and other adverse weather conditions), conflicts, and wars. Women and children most often carry out the task of gathering water. Compounding the problem are demographers' predictions that the world population will increase by approximately 33 percent over the first 25 years of the twenty-first century. As this century opened, the world population was just over 6 billion. *At present growth rates, it will to —7 billion by 2013 and—8 billion by 2028.* Much of this growth is expected to take place in developing countries, many of which are already burdened with serious drinking-water problems.

In India, modernization and industrialization has left water table, depleted. Water table has fallen 1000 feet in some places. Industries need billions of gallons of water. There is no surface water available. Besides exploitation of river sand for construction purposes has pressed water level in to greater depths. Earth and its worker are hurt. My question is, "When Earth is hurting, who responds?" The answer is, I believe, that each of us now experiences in some way—physically, psychologically, economically, socially, religiously or politically—the pain of the Earth. We priests feel so much of pain as pastors. The news about water shortage and water pollution is hard to avoid. Anyone, who walks, breathes, looks, or listens knows that the water, the air, and the soil are being contaminated and that nonhuman species are disappearing at alarming rates. *My appeal is to save fish in the Hydrosphere. Today, we need more people, who abstain from eating fish. As priests we should be saving all life, remember—we are "pro-life." Not only human life, we should be consistently "pro-life"—with all life. If we 400,000 priests, 5,000 bishops and 850,000 nuns don't consume fish, that would be a great leap of faith, then convince our 2 billion of Christ followers not to eat fish. We could save considerable amounts. After all our mission is to save what has been lost. Over-fishing exterminated species after species of fish.*

There is no enough fish left for other fish to eat. Whales and dolphins are dying in great numbers of hunger, because they don't have enough fish to eat. Marine ecosystems are disappearing at an alarming rate. Thus a total of almost 80% of the world's fisheries are fully to over-exploited, depleted, or in a state of collapse. Worldwide about 90% of the stocks of large predatory fish stocks are already gone. Yet the great majority of us, in this country and in much of the world, seem to be living our lives as if this were not so. *Because we experience the self as separate from the Earth. We are disconnected from nature. We are in disharmony with the Earth because we are in disharmony with ourselves.* Consequently, Hydrosphere is wounded and bleeding. Remember we are 80% water. Humankind is facing now than ever an absolutely unprecedented crisis for drinking water. As priests and leaders of faith community, please make an appeal to save water and its fish on Earth. When we waste water, we show disrespect to life. When we save water, we save life. *I do not know how many future generations we can count on before the Lord returns, whatever it is we have to manage with a skill to leave the resources needed for future generations.*

Water the Creator - The Day the Rains came!

Those formative years were steamy times on Earth, for all the water was in the sky. And then one day, somewhere between 4.4 and 4.0 billion years ago, the temperature had fallen far enough for water to condense. Clouds massed in the sky, and the oceans rained down. The deluge resulted from these rains, must eventually have ensured that leaves the biblical version looking like an April shower. This was the original Flood, and had anyone been there to witness it, I don't think an ark would have done them much good. Far from eradicating life, this deluge set the stage for life's entry. It turned the face of the world blue and created a planet that exists—in atmospheric scientist James Lovelock's words, as *"a strange and beautiful anomaly in our solar system."* The brown Earth became a blue water world. It is one of the four elements of classic antiquity. It is a geological force that shapes mountains and coastlines, with a might that is unleashed—in the destructive fury of hurricanes and floods. Water is fabric of snow, hail, steam, and ice, and the only substance able to exist on Earth in all three of its physical states: solid, liquid, and gas. Water is central to our planetary environment. Life's matrix tells of water's origins, its history, and its fascinating pervasiveness.



A provocative exploration of water on other planets highlights the possibilities of life beyond Earth. Life's matrix reveals the unexpected in the most ordinary places, a drop of dew, a frozen pond, a cup of coffee, and the familiar in unexpected settings. There is water on the sun and the moon, at the heart of molecular biology, at the core of a cell, and there may be enough of it—beneath the surface of the Earth to refill the oceans—thirty times over. Life's matrix also surveys the grim realities of our natural resources, and shows how water will become a scarce commodity in the twenty-first century. Life's matrix offers an exhilarating exploration of one of the oldest, most idiosyncratic substances known to mankind, and ensures that we will never think about water in the same way again. Some substances become mythical. They transcend their physical and chemical materiality and manifest themselves in our minds as—symbols, as qualities. In the collective unconscious of a culture, their material constitution becomes secondary to their symbolic value. Gold, to the chemist, was more than a metal—it was perfection, the goal of a spiritual quest.

Water is as old as God himself. While the Earth was formless and empty, the Hebrew God was "hovering over the waters." There was no sky, no dry land, until God separated "the water under the expanse from the water above it" and commanded that "the water under the sky be gathered to one place." Then the world emerged, from an infinite primeval ocean. This is echoed in similar myths throughout the world. In central and northern Asia, India, and Russia, a recurring motif is that of the Earth Diver—an animal or a god who plunges to the bottom of a primordial ocean to bring up a seed of Earth. The Polynesian cosmology reproduces that of the Old Testament in extraordinary detail: the Supreme Being Io says "Let the waters be separated, let the havens be formed, let the Earth be!" For the Omaha Native Americans, all creatures once floated disconsolately on a wholly submerged Earth until a great boulder rose from the deep. In Hindu mythology, the sound that embodied Brahma* became first water and wind, from which was woven—the web of the world. *"Darkness was there, all wrapped around by darkness, and all was water indiscriminate"* says the beautiful creation hymn of the Rig Veda (3700 BC).** For the Maya of Central America also, the deity Hurakan called forth the land from a universe of darkness and water.

Water the Destroyer – The Day the Floods Came!

If he holds back the waters, there is drought
If he lets them loose, they devastate the land. Job 12:15

Nearly every culture has a legend of a catastrophic flood that destroyed the world except for a chosen few. Noah is familiar throughout the western world and Atlantis too; but similar tales are to be found in cultures from India to Peru, New Guinea to native North America. Noah's voyage to the peak of Mount Ararat*** has its origins in the Assyrian and originally Sumerian legend of Gilgamesh,**** dating back at least as far

*Brahma is the first member of the Hindu Trinity. Within the Hindu Trinity of Brahma, Vishnu and Shiva, Brahma the creator, Vishnu the preserver and sustainer of life, and Shiva the destroyer of evil.

**Rig Veda is a group of poems and prayers that were first sun and recited for thousands of years in Hinduism.

*** Mount Ararat, the traditional resting place of Noah's Ark, is located in eastern Turkey near the Armenian and Iranian borders.

****The epic of Gilgamesh was the first written epic poem and one of the oldest pieces of literature in the world. It was a eulogy to Gilgamesh, king of Uruk. It was originally written on 12 clay tablets in cuneiform script. Gilgamesh, originally a Sumerian legend recopied by the Assyrians, was composed and recited many times before written down. It was part of an earlier oral tradition.

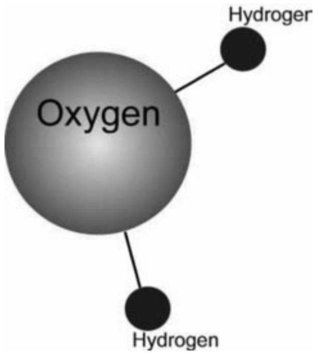
as 2100 BC. But whereas Noah's God sought to cleanse the Earth of a corrupt and sinful people it seems that Enlil, the chief god of Gilgamesh's pantheon, called down the heavy rains simply because the people who lived on the broad Earth were too noisy and disturbed his sleep. Only Utnapishtim—king of the city of Shurippak on the Euphrates, and his family and entourage were spared destruction, since the king was forwarded by Ea, god of wisdom, to build an ark. It isn't hard to see how such legends might have arisen in the pre-biblical Middle East, where the Sumerian cities along the Euphrates and the Tigris rivers were in constant danger from the massive floods of which these rivers are evidently capable. But the ubiquity of such legends testifies to the uneasy relationship of ancient civilizations with their water supplies.

At a time when pack animals and foot travelers could move overland only by roads and paths that led them slowly through dense forests, across deserts, or over mountain passes, over territory that was often dangerous physically or because of the risk of attack by robbers, river journeys were to be preferred. Though not without risk, river travel was generally safer and certainly less arduous than land travel. Life on a river bank is not always secure, however, for the river may flood, and *floods provide a recurring theme in the ancient myths of many peoples.* Zeus once inundated Greece as a punishment, for example, sending floods from which a few people escaped by climbing to mountain tops. A king, Deucalion survived, and saved his queen Pyrrha—by building an ark, the gods had given advance warning. The story of the Biblical flood, another punishment, is based on a tradition from the eight century BC, but the story was already ancient. The earliest of many accounts of it was written in Sumerian, probably more than 4000 years ago, and geological evidence suggests it may recall a particularly devastating flood of the Tigris and Euphrates—rivers which occasionally cause serious flooding to this day. If the flooding is a recurring theme, so is the ark by which one particularly favored individual is permitted to escape, taking his family and possessions with him. The ark, of course, was a boat, and its occurrence in such ancient myths demonstrates the antiquity of this means of transport.

It is an uneasiness that persists today, when huge centers of population remain at threat from flooding. There are, broadly speaking, two types of flood—those caused by rivers bursting their banks and those that occur in coastal areas due to high sea swells, water waves, and hurricanes. Because of changes in human activities and demography, the risks and damage caused by these floods are increasing in global extent. Today, around 40% of the deaths from the acts of nature, as well as 40% of the societal costs of natural disasters, are the result of floods. The floods in Northern Pakistan and India, in 1992 killed more than two thousand people and left hundreds of thousands homeless. And the combination of the Ganges, Brahmaputra, and Megna rivers in Bangladesh leaves most of this low, fertile country, most of which is less than ten feet above the sea level, susceptible to flooding to depths greater than thirty-five inches every year. The facilities available to countries like India, Bangladesh, and China, where huge numbers of people live in constant danger of floods, are far more limited.

The fabric of Water

Water contains two elements—the H and—the O, which unite so readily to create our subject. Water is H2O, the only chemical formula that everyone learns: two atoms of hydrogen welded to one of oxygen. Their union is a molecule, a cluster of atoms. Chop up a block of ice, and keep changing, and your finest blade, finer than the keenest surgical scalpel, will eventually reduce the fragments to these individual three-atom clusters. If you chop beyond that, you no longer have water. *The H_2O molecule is the smallest piece of water you can obtain, the basic unit of water.* So here is a central aspect of water's character: it is a compound, an association of atoms, divisible into atoms of different natures. Yet water is so fundamental to the world that for millennia it was mistaken, naturally enough, for an element, something indivisible. Hydrogen and oxygen are enough, for an element, because they each contain only one kind of atom. But there is no "water atom", only a water molecule, made up of two different types of atom.



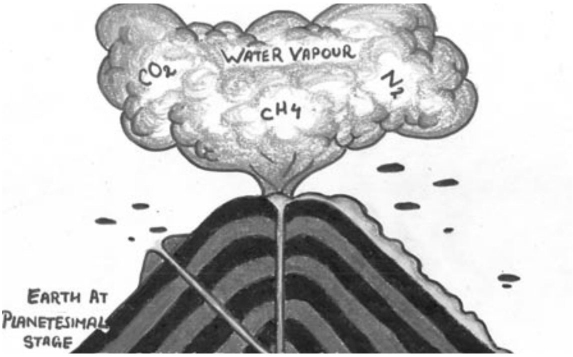
Before water could come into universe, there had to be hydrogen and oxygen atoms. Oxygen is the third most abundant element in the universe, albeit a very poor third to hydrogen and helium, whose primordial generation in the big bang ensures that they constitute almost all of the fabric of creation. But helium is un-reactive—a cosmic loner.

And so should we after all be surprised that water, the combination of the universe's most popular reactive elements, is so pervasive? This molecule, the matrix of life, is the product of the universe's two most generous acts of creation—the big bang,* which started it all and gave us a cosmos made mostly of hydrogen; and stellar evolution, which reformulates this element, whose very name means "water former", into oxygen and all the other elements that make up the world. Within the imponderable expanses of interstellar space, these two elements unite, and there in the making is the river Nile, the Arabian Sea, the clouds and snowflakes, the juice of cells, the ice plains of Neptune, and who knows what other rivers, oceans, and raindrops on worlds we may never see.

Origin of Water

No, planet formation is less stately and more traumatic than this. The accretions of gas and dust in the solar nebula formed smaller rocky bodies

The big bang is the biggest cosmic explosion which is believed to be the beginning of the universe called—planetesimals that range in size from boulders to moon-sized asteroids. These swarming planetesimals engaged in fearsome collisions that smashed each other to rubble, but the rubble from each collision then cohered into a single, larger object through the tug of its own gravity. Rather like companies, larger planetesimals grew at the expense of smaller ones until the disk was swept free of debris and only the planets remained the multinational conglomerates of the solar system. The inner planets—Mercury, Venus, Earth, and Mars, are relatively small, dense, rocky orbs. But out beyond the asteroid belt, where some of the smaller debris escaped capture, the planets were able to retain vast envelopes of gases and liquids: here we find the gas giants—Jupiter and Saturn, and the frozen worlds of—Uranus and Neptune. The heat generated during its formation from colliding planetesimals created a global inferno. And around 4.5 billion years ago the Earth seems to have collided with a planetesimal about the size of Mars. It sheared off enough material to form the moon, boiled away any atmosphere that the Earth then possessed, and left the planet a ball of molten rock (magma) for millions of years, its surface awash with a fiery ocean from pole to pole.



Yet collisions were not wholly destructive. On the contrary, they ultimately gave the planet—an atmosphere, water, and the—possibility of harboring life. In the part of the solar nebula where the Earth condensed volatile substances like water and carbon dioxide were rare commodities, only farther out, where the temperature was low enough for them to condense and freeze, could they become a major component of planetesimals. These colder bodies could sequester a coating of ice from

*Planetesimals are the seeds of planets crash together in the solar nebula, gradually growing larger.

the gas and dust, just as snowflakes high in our atmosphere sweep up water vapor from the air. Blundering in and out of the nascent inner solar system, such objects most probably added water to the rocky mixture that was becoming the Earth. To test whether this idea holds water, so to speak, planetary scientists today study the composition of meteorites. They are still raining down on us from the skies, albeit in far smaller numbers than when the world was young. Many meteorites do indeed carry a bountiful crust of ice, not just water ice, but also frozen carbon dioxide, ammonia, and other volatile compounds. Meteorites called carbonaceous chondrites, which are rich in carbon compounds, can contain up to 20% water, either as ice or locked up in the crystal structures of minerals. The most abundant type of meteorites, ordinary chondrites, carry much less water, around 0.1% of their mass. Yet even this would have been more than enough to fill the oceans if the Earth was formed primarily from planetesimals with this composition. Also, volcanoes were responsible for bringing out steam and water vapor, contributing to Hydrosphere.

But meteorites are not the only objects still wandering among the planets. There are itinerants the size of mountains out there, and they could deliver huge quantities of water to the Earth and its neighbors in a flash. *I'm talking about comets, the unruly rubble of the outer solar system*. Comets mostly originate in a roughly spherical cloud of objects stretching way beyond the orbit of the most distant planetesimal. Pluto perhaps more than halfway to the nearest neighboring star system. This halo—called the Oort Cloud,* contains around a million and million comets, whose immense, looping orbits bring them occasionally sweeping through the inner solar system, as we saw in spectacular fashion with comet—Hale-Bopp in 1997. *They consist mostly of volatile gases condensed into ices, of which by far most abundant is water.* Mixed in with the ice is a scattering of mineral dust, making comets immense dirty snowballs. Generally they are several hundred feet to several miles across, and so contain an awesome amount of water. Halley's Comet, for instance, is a potato-shaped lump about eight by sixteen km in size, with

*The Oort Cloud is a collection of icy comets far beyond Pluto. It is the farthest place from the sun in the solar system. The Oort Cloud marks the end of the solar system because beyond it the sun's gravity is too weak to hold anything so it will be pulled away from the sun. It surrounds the planets like a cage. The Oort Cloud is about 8 million kilometers in diameter.

a mass of about one hundred billion tons, most of which is ice. A typical comet is still larger, containing around one trillion tons of water. A million comets like this would be enough to supply all of Earth's oceans. Comets and volcanoes are responsible for all the water on Earth.

The last major collision of comet with Earth may have been happened some sixty five million years ago. But comets swarmed through the solar system in far greater numbers, when the Earth was forming, and would have crossed paths with the planet far more regularly, bringing oceans on their backs. It seems that the gravitational tug of the outer planets Uranus and Neptune, as well as nearby stars, helped to rearrange the orbits of comet-like planetesimals in the Oort cloud so that they would pass more often through the inner solar system. Meanwhile these and the other giant planets, particularly Jupiter, eventually swept up most of the debris from the solar system and so quieted down the game of cosmic billiards by about a billion years after the planets are formed. Had this not happened, huge impacts might have delayed the appearance of life on Earth for billions of years. So we may have our neighbors to thank not only for our oceans but also for the life that spawned in them. Oceans did not appear until many millions of years after the planet was formed. Four and a half billion years ago the Earth was still a molten magma ball, seething from the collision that ejected the moon.

As the planet cooled, its constituents separated like curdled milk. Within about fifty million years, the iron of which much of the Earth was comprised had sunk to the core, and the lighter elements silicon, aluminum, calcium, magnesium, sodium, potassium, and oxygen, along with some remaining iron, formed a rocky crust at the surface, just as slag floats on top of molten iron in a smelter. Among all this rocky stuff were the volatile compounds delivered sulfide, carbon dioxide, water. While the Earth was molten, these volatile compounds dissolved in the magma, but as the molten rock cooled and solidified, the vapors were released in a process called—the degassing. The atmosphere that resulted from degassing was very different from today's consisting mostly of carbon dioxide, nitrogen, and water vapor. Hydrogen is too light to be retained by the Earth's gravitational field, and was gradually lost from the early atmosphere into space. For this reason, the Earth is steadily losing its water too, albeit very slowly. The sun's ultraviolet rays split water in the upper atmosphere into its constituent hydrogen and oxygen atoms, a process—*called photolysis*. The hydrogen then escapes into space. This water-splitting costs the planet the equivalent of a small lake's worth of water each year. That sounds like a lot and it certainly would be if it all came from a single lake! But averaged over the amount of water on the planet, the loss is probably quite small: photolysis may have reduced the Earth's water reserves by just 0.2 percent since the planet was formed.

The Beginning of Life on Earth

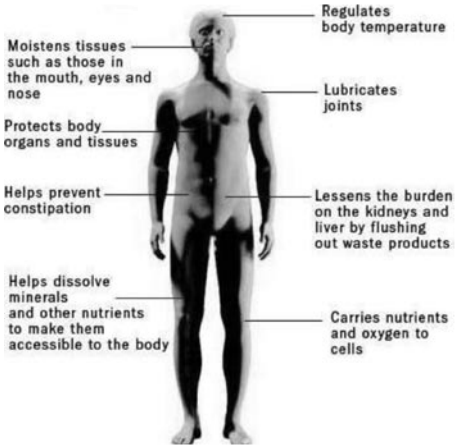
Where there is water, there is life. Conditions on Earth today are quite unlike those that existed billions of years ago, but you can still see the kind of environment in which life may have begun, and in which it is still abundant. Find a tidal creek or inlet where the climate is warm and the water is shallow. Probably the tidal range will be fairly small, so that each high tide brings in a little water to replace that which was lost by evaporation, but without disturbing the site too violently. The sea will bring in a load of chemicals on each tide and, between high tides the water will be warmed sufficiently to encourage reactions. Allow, also, that thunderstorms produce nitrate and that from time to time the water is struck by lightning, to supply some electrical energy. In these conditions quite complex molecules form reasonably readily.

Life will not be evolving anew in tidal creeks today or anywhere else so far as we know, because it exists already in such abundance, and the chemical raw materials are taken up and utilized before there is time for them to start the evolutionary process all over again. It is not difficult to gain an impression of the extent of this abundance. Take a sample of the water, collected at random in a jar, and watch it carefully with a strong magnifying lens. The tiny particles, moving about rapidly, are living organisms. There is no proof that this is where and how life on Earth began, and some scientists are coming to the view that the early part of the process took a short cut. *Complex, carbon-based molecules,* *resembling tars, are known to exist in comets and in some meteorites.* The early bombardment of the Earth may very well have injected large amounts of these chemicals. Most would have been destroyed by the heat generated by the friction of their passage through the atmosphere and by the impact, but if the density of the atmosphere was markedly greater then than it is now, which it may have been, the bodies would have been slowed down, perhaps sufficiently to permit a proportion of their large molecules to survive. *If this is what happened, it would have supplied ready-made a stock of substances necessary to the emergence of living organisms that otherwise would have taken a long time to form and accumulate.*

The idea of such a short cut helps to explain how it was that life appeared on Earth so soon after the planet formed, and we can be very certain that it did, and *that it was associated with water.* Some of the oldest rocks in the world have been found in western Greenland. They have been dated as 3.8 billion years old. The Greenland rocks are enriched in carbon-12. That is to say, they contain a higher proportion of carbon-12 in relation to carbon-13 than is found in ordinary, atmospheric carbon dioxide. Carbon has two stable isotopes, carbon-12, and carbon-13. The atoms of elements can exist in different forms, called—*"isotopes,"* that are alike in the number of protons contained in their nuclei, but that differ from one another in their number of neutrons. The proportions of the two stable isotopes are constant in the carbon released into the atmosphere from volcanoes, but in the first stage of photosynthesis carbon-12 is used in preference to carbon-13. The discovery of carbon-12 enrichment in the Greenland rocks, therefore, suggests very strongly indeed that photosynthesis was established at the time the rocks formed. Not only was liquid water present on Earth 3.8 billion years ago, but living organisms were also present and had been present long enough for photosynthesis to have evolved.

Life Dependence on Water

Living cells, regardless of where they occur, have never lost their dependence on water. This is not because life evolved in the sea, and land-dwellers have been only partially successful in serving this link with their evolutionary past, but because of the characteristics of water itself. It is those characteristics that favored the chemistry which led to the emergence of self-replicating molecules, and the subsequent development of more complex structures. It is not our link with the oceans that we retain, but our use of water as the medium for our body chemistry, and *no other naturally occurring substance can provide a substitute.* It is inconceivable that any evolutionary line could ever lead to organisms that had no need for water, although many plants and animals are very economical in its use, and some cells can survive desiccation and revive when moistened.



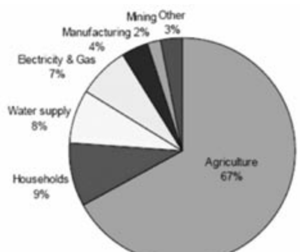
It is easy to see that a jellyfish almost transparent and drifting in the sea, consists mainly of water and, if you have seen jellyfish on the beach, marooned by the tide, you will know that once removed from the sea they soon dry out and die. It is less obvious that fishes are also mainly water, and less obvious still that so are land animals, including the mammals, yet water accounts for most of the content of all cells and, in animals, of most of the blood and other body fluids. A cow may secrete as much as 60 liters of saliva a day, for example, and about two-thirds of the weight of a human body is water. *An adult male human has about 5 liters of blood, an adult female about 4 liters, and children proportionately less.* While cells are free-living, they are able to absorb the substances they need and remove waste products simply by passing molecules in and out through their walls. In an animal such as a sponge, which consists of a colony of semi-autonomous cells, the overall arrangement allows each cell to be in contact with circulating sea water. Where the cells are specialized, and joined together to form the body of a larger animal, however, they have no such direct contact with the outside environment, and some mechanism is required to convey to them the molecules they need, and to remove wastes that might otherwise accumulate until they reached concentrations that were harmful to the cells themselves. Body fluids, which are mainly water, provide the medium in which products can be transported.

Life as we know it cannot exist without water, and we don't have to look very far for it: the Pacific Ocean, our world's largest feature, covers one third of the Earth. Water is our most abundant liquid and odorless substance that is colorless in small amounts, but takes on a bluish tinge in large quantities. Water in its solid form, ice, and its liquid form, it covers more than 70 percent of the planet. The white swirls that usually block the view of the planet from space are clouds, composed, naturally, of droplets of water. The average depth of the oceans is about 12,000 feet, *and the deepest spot in the world is located in the Marianas Trench, some 35,840 feet below the surface of the Pacific, 6,838 feet deeper than Mt. Everest is high. If Everest sat at the bottom of the Marianas Trench, and Edmund Hillary and Tenzing Norgay stood on its peak, they would be under a mile and a half of water.* Water is the stuff of life on Earth; protoplasm is a suspension of a number of substances in water, and every living thing is made of protoplasm. Water is also the home of nine tenth of the Earth's living things. Most of them breathe dissolved oxygen, not the oxygen in H_2O. The earliest life forms on Earth evolved in water; they were microscopic and soft-bodied, without skeletons or shells, and they left few records of their existence.

Importance and Uses of Water

Some scientists believe that at one stage in human evolution our ancestors were semi-aquatic. They lived beside water, rivers, lakes, or the sea and spent a great deal of time in the water seeking the fish and shellfish that formed a major part of their diet. This, the scientists maintain, explains such features as our almost complete lack of body hair and the thick layer of insulating fat just below our skins, as well as the ease with which young children learn to swim. These are characteristics we do not share with the other primates to which we are closely related, the chimpanzees and gorillas, but they are possessed by aquatic mammals, such as seals. The idea controversial and most biologists reject it, but there is no doubt that humans show a preference for living close to water. *A glance at a map is enough to demonstrate how many of our major cities lie beside rivers or a sea coast.* Water is essential to life, of course, but it is perfectly possible to obtain enough for our biological needs from natural springs, or by conserving rain water. A more obvious explanation refers to our social, rather than biological, needs. We live as members of societies and each human society is in contact with its neighbors. Very early in our history such contacts brought the realization that most societies produce surpluses of some goods, are deficient in others, and that trade is possible. People made encampments beside rivers partly to drink from their waters and to wash in them, and partly to fish them, but mainly to ride on them. It was from this need for communication that some of the riverside encampments grew into villages, then towns, and eventually into great cities. Today, our dependence on water has escalated, such as agricultural use, industrial use, and domestic use, that left Hydrosphere exploited, over population puts constant pressure on water resource, while year after year less rainfall adds more drastic changes to the environment.

So large is our demand for water, for many industrial uses and domestically for cooking and washing as well as for drinking, that, even in high altitudes, and in climates such as that of Britain, where a relatively high average annual rainfall is distributed fairly evenly throughout the year, water shortages are quite common. After a few weeks without rain, in summer when the rate of evaporation is high, reservoirs are depleted, river levels low, and some form of rationing must be introduced. In extreme cases, domestic supplies must be disconnected so that householders are compelled to collect water from street standpipes. *We fear drought,* but not because it brings a risk of dying from thirst. Indeed, the need for drinking water does not enter into the definition of a drought. Crops fail and there is starvation long before supplies of drinking water are exhausted. People depend on water for various purposes, such as irrigation for agriculture, for producing electricity, for drinking, for industrial use, and to maintain livestock. Shortage of water puts pressure on daily life. Many people around the world, Africa, Australia, and India face shortage of water every year, due to failure of monsoons and drought.



A drought will occur if the amount of water reaching the ground as rain over a given period is less than the amount that, were it present, would evaporate from the surface during the same period. Obviously, a drought is more likely in hot weather but, if the rainfall is low enough, it can occur anywhere in the world. Desert is the region where only about 2 inches of rain falls in a year. When the rate of evaporation exceeds the amount of water falling as rain, water is drawn upwards through the soil, only to evaporate from the uppermost layers. This depletes the ground-water, and the water table falls until it lies below the reach of plant roots and, although water continues to move by capillary attraction, as the soil dries, the resistance to such movement increases rapidly. At this point the vegetation begins to suffer and, unless water is supplied, the plants will die. The safety margins are narrow and ripening crops benefit from irrigation during dry weather that falls far short of drought.

Most of our common plants, trees, grasses, crop plants and our garden plants, apart from the simpler types such as mosses and liverworts are "vascular." That is to say, they contain tubes, or "vessels," through which water passes. The stem has parallel, vertical vessels which branch repeatedly at ends, the lower end in the root region and the upper end at the leaves. Plant cells literally gorge themselves with water. This distends them and makes them fairly turgid, rigid, like tiny inflated balloons. Like the earthworm, a plant uses water to give its tissues rigidity. If the flow of water is insufficient, cells are unable to remain turgid. They relax, the structures they comprise become limp and, except in the case of trees and shrubs, whose mechanical support is provided by wood, made from accumulated dead cells, the entire plant wilts. The plant will recover rapidly if water is supplied to its root area, although not in the case of "temporary" or "midday" wilting.

The plant also requires water for photosynthesis, the chain of reactions in which glucose is synthesized from simple ingredients using the energy of sunlight and chlorophyll as a catalyst. Different groups of plants have adopted two distinct strategies. In one, the leaves are covered with a waxy substance that reduces the amount of water passing out of them so that, in effect, the plant can seal itself to retain adequate water content. Conifers combine this with drastically reducing the size of their leaves until they are needles. Because the stratagem is equally effective whether the drought be accompanied by warm weather or cold, conifers flourish in—Mediterranean climates as well as—in the pine forests of the north.

The alternative is to dispose of leaves altogether during the dry season. As winter approaches, a deciduous plant withdraws nutrients from its leaves. They wither and, as the chlorophyll breaks down, other pigments dominate to change their colors.

Finally, the plant secretes a hormone that breaks the leaf attachment and it falls. Most, but not all, deciduous plants are broad-leaved. Evolution on land has taken plants and animals into most parts of the world, but it has not reduced their dependence on water. It could not, for life without water is inconceivable.

Sweet Fresh Water

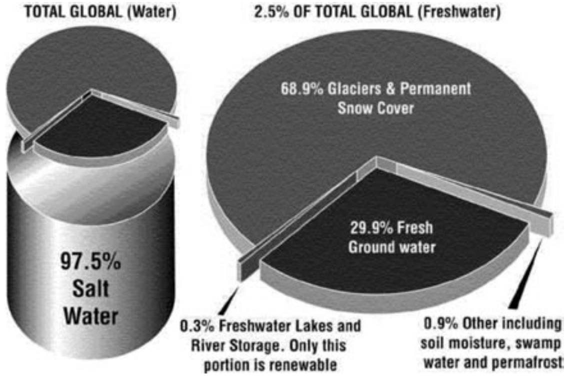
This is how the journey of fresh water starts. The snow flakes fall so gently on the mountains of the world. Their lower layers, compressed by the weight above, turn to ice. It closes around projections of rock and penetrates the cracks and joints.

As the snow continues to fall above, the ice beneath begins to move slowly down the steep slopes under its own weight, dragging away plates and blocks of rock as it goes. Most of the time, the movement is so slow that its only visible signs are widening cracks across the snowfield. On occasion, the whole sheet suddenly loses its grip and thousands of tons of ice, snow and rock sweep down the mountain—called an avalanche. All this frozen water, gathering in the vast couloirs between the mountain ridges, unites to form a river of ice, a glacier.

As the glacier slides downwards, it scrapes away at the sides of the valley against which it presses. Beneath, boulders frozen into its underside, like teeth in a gigantic rasp, grind down its bed. Ahead, it pushes a huge wall of shattered rock. Slowly it inches downwards below the level of permanent snow until the warmth begins to melt it, and water, creamy with pulverized stone, gushes from its snout. Rain, falls on the mountain at these lower altitudes.

During the day, it trickles harmlessly over the bare rock faces and permeates their crevices, but at night, when it freezes, it expands and wrenches away splinters and flakes which tumble down to join the piles of angular fragments skirting the bottom of the cliffs.

The rivulets unite into streams and join the waters flowing from the glacier. Together, they tumble and eddy down the valley as a young and violent river.



The water, in global terms, is a rare liquid. Ninety seven percent of all the water on Earth is salty. This, although it carries many rock particles in suspension, is chemically very pure. As it fell from the clouds through the atmosphere, it absorbed some carbon dioxide and oxygen, but very little else and so far it has had little chance to dissolve minerals from the newly exposed and largely unweathered rocks it has crossed. But gradually, as it rushes on, it collects organic particles from the mountain plants growing between the boulders near its margins, and eventually it acquires just enough dissolved nutrients to support animal life. Sweet fresh water is found in many places; they sustain millions of organisms, such as grass, plants, fish, amphibians, reptiles, birds and mammals. The following places, nature stores water for later usage of organisms.

Surface Water – Water found on the surface of continents and islands are referred to as surface water. Surface water makes up only one fourth of one percent of 0.025% of the total water found on Earth. This water is found in rivers, streams, lakes, springs, and 6 are. Streams have an important job. They drain the landscape, and move water, and minerals towards the Earth's oceans. As water drains it generally begins in small creeks, which flow into larger and larger streams, and eventually into powerful flowing rivers. The largest river on Earth is the Amazon, which drains much of South America. The largest river in North America is the Mississippi River, which drains over 40% of that continent.

Lakes – Lakes store fresh water (more to read later in the book)

Underground Water – Locked deep within the lithosphere, or surface of the Earth, is found many billions of gallons of water. Almost anywhere on Earth, it is possible to dig down, and find a supply of fresh drinkable water.

Almost all of this water was deposited over millions of years by the many rain and snow storms that have visited the surface of the Earth. Most ground water lies within a kilometer of the surface of the Earth. However, scientists have found water at a depth of more than 9 kilometers.

The Great Arteries – The Rivers

The great rivers of the world have a profound resonance even for those who have never set eyes on them. The names alone are enough to conjure up dark tales of exploration and adventure, romance and intrigue: the Congo, the Amazon, the Nile, the Ganges, the Kaveri, the Volga, the Seine, and the Danube. Perhaps it is too facile a connection, but I cannot help but wonder whether the stirrings that these names evoke are an echo of an ancient significance of the world's waterways, which offered travel in an age before airlines and abundance in an age before supermarkets and global agro-industry. The water that bathed and nurtured the roots of human civilization was fresh, not salt. All of the four oldest great civilizations sprang up by rivers and their fertile floodplains: Mesopotamia bracketed by the —Tigris and the Euphrates; the Harrapan Culture* on the Indus; China on the mighty Yangtse and Yellow rivers from the brow of the Tibetan Plateau; Egypt on the Nile. The fundamental nature of this dependence on water is reflected linguistically in Persian, in which the first word of the dictionary is — *ad, meaning "water."*

Herein lies the root of the word abode, from the Persian Abad; and derived there from is Abadan, "civilized." Quite literally, water constitutes the beginning of civilization. Needless to say, how the power of water in baptism would spiritually transform a human being giving him a jump start for Christian life.

Today, rivers remain a source of plenty—of water for domestic supplies —for cooling, cleaning, and other industrial purposes; for agricultural irrigation; for energy generation via hydroelectric power. For many people of the world, rivers supply the staple protein intake in the form of fish, and their significance as routes of trade and transportation

*Human inhabitation in the Indian subcontinent is traced to the Paleolithic and Neolithic period. Dated from about 2500 to 1500 BC, this civilization is considered to be at par with the other civilizations of the world. Sir John Marshall and his team excavated the ruins at Mohenjodaro in the Larkana district of Sind in the lower Indus and at Harappa on the banks of the Ravi River has brought to light the existence of the Indus Valley Civilization.

remains hard to overstate. They supply profound inspiration to artists and poets and to scientists also.

The metaphor of a river recurs throughout myth and literature. Tales of epic exploration on the world's rivers abound. *The Nile, stepped in Egyptian myth of death, resurrection, and fertility, its waters attributed a healing potency even as the seventeenth century, is the archetype of all rivers.* At Khartoum in Sudan it converges with the White Nile, whose sources lies deep in the central African continent. John Speke identified this source as—Lake Victoria in 1858, and in 1860 he established—the Kagera River in Burundi as the Nile's southernmost point. David Livingstone* found the source of the Congo on an expedition launched in 1866, but his quest for the still-disputed source of the Nile was curtailed by his death from malaria in 1873.

*David Livingstone, missionary to Africa, was born in 1813 and lived 8 miles south of Glasgow. He died in central Africa, 4th May 1873.

Other rivers have long been major arteries of commerce. The Rhine, which makes a journey of 1250 km from the Austrian Alps to the North Sea at Rotterdam, is navigable as far as Basel in Switzerland, and is linked by canal to the Ruhr industrial region of Germany and recently via the Rhine-Main-Danube waterway to the Danube, Central Europe's longest river, and thence to the Black Sea.

But it is perhaps in the twin threads of the Tigris and the Euphrates, which empty into the Persian Gulf, that we can see the most profound role of rivers in human history. For in the land *"between two rivers"*, which is how the Greek name of Mesopotamia translates, nomads settled on the fertile flood plain in 8000 BC, to become possibly the first farmers and herders in human history. There followed a succession of great civilizations—Babylonia in the lower valley from around 5000 BC, settled by tries from near the coast of the Gulf: Samaria in southern Mesopotamia from around 3100 BC.; and Assyria in the northeast from 2000 BC. The need for coordinated irrigation to support the Babylonian settlements spurred the development of one of the earliest governmental structures, and also of industry, for coordinated engineering was required and foreign trade in raw materials. The Sumerians* made canals along the Tigris at least as far back as 2400 BC. In this fecund land we can discern how water brought culture and learning, social order and technological advancement, to the ancient world.

The Nile is the longest river, 6,683 km from the source of the White Bile in Burundi to the Nile's outflow in the Mediterranean Sea, but is rather thin and straight, with a catchment never exceeding 1940 km in width. The Amazon is just 217 km shorter, but it sprawls more widely to encompass a catchment of over twice the area of the Nile's: 2.7 million square miles, an astonishing 5 percent of the world's total land surface area. In part these differences can be ascribed to the differing climates of the two regions: much of the Nile runs through dry, parched lands for most of the year, whereas the Amazon's moist rain forest experiences extensive precipitation, giving it a wider source area and a greater annual flow than the Nile.

Of the different shapes that rivers and streams can adopt, *two of the most common are called—meandering and braided.* Meandering rivers

*Sumerians were the first civilization to occupy the Tigris-Euphrates River valley called Mesopotamia.

change their course over time like a writhing snake, sometimes fast enough to complicate surrounding agriculture. Shifting meanders may leave behind them oxbow lakes where bends have approached close enough to fuse. These fusion events take place because the outside edges of each loop are always pushing farther out, since erosion is greatest at these points. *Braided rivers on the other hand,* follow a complex, interwoven network of paths separated by islands and spits. They seem to be the result of high sediment transport in the river water, a factor underlined by their similarity in appearance to small streams of water flowing over flat sandy beaches to the sea.

Streams and rivers are a major shaping force of geology. They redistribute sediments to the tune of around sixteen billion tons each year, a figure that has arisen dramatically since prehistoric times owing to human activities such as agriculture and dam building. These sediments, as they are dumped at vast river deltas, may gradually extend the borders of the continents. Rivers carve highlands into rugged landscapes, wearing away solid rock by a variety of processes. Sand and small stones carried by the flow grind away at the riverbed, slowly carving out delicate flow-forms by abrasion. Larger rocks and boulders carried by more violent flows may crack and splinter the channel's boundaries. And ever the universal solvent, water erodes by chemical action too, dissolving minerals and releasing their elements into biogeochemical cycles.

The Blood of the Earth – The Power of Water

Long adapted for land life, we have never truly come to terms with the dominance of the seas. These huge watery plains are hardly less scary today than they were to our ancestors, who populated their nether reaches with fabulous beasts and feared the chasms that lay just out of sight over the horizon. Even the deserts hold fewer terrors. We have colonized the dense, steamy valleys of Amazonia, the frozen Arctic wastes, and the starkness of the Siberian steppe, and yet we remain a little nervous even about what lies in the depths of the Scottish Loch Ness,* let alone the unplumbed abysses of the great oceans. In some ways we know more

*Loch Ness is a large, deep, freshwater lake in the Scottish Highlands extending for approximately 37 km southwest of Inverness. Its surface is 45 feet above sea level. Loch Ness is best known for the alleged sightings of the legendary Loch Ness Monster, also known as "Nessie."

about the moon, Venus, and Mars, reassuringly free of liquid water, than about the ocean floor. So we have a curious relationship to water on Earth. It nurtured and sustained civilization, yet the fresh waterways that fed the cultures of ancient China and Egypt, Mesopotamia and the Indian subcontinent make up barely a tenth of a thousandth of all the liquid water on the planet. Just about all of the rest is salty, and lethal to the thirsty adventurer. Water giveth and taketh away, in floods that resound through the legends of many cultures, in hurricanes and other wild faces of nature. Water has carried explorers far afield, yet it swallowed up our puny vessels without a trace. The water gods exemplified by Poseidon* in Greek mythology, are ambiguous creatures with aspects both benign and terrible. Throughout the Book of Job, the contingencies of nature's waters are a continual metaphor for the trials of humankind.

The naïve psychological perspective associates water with life, and I will later say much that reinforces this institution. But at a mythological level, the natural waters of the Earth offer humankind a journey into death. The Styx** the Ganges even today a repository of the deceased. The Nile and the Tigris were not only holy in Near Eastern belief but dwelling places of the dead, ruled by demigods with the power of resurrection. *From the association of streams and rivers with death and rebirth comes the Christian practice of baptism*. But it is also via the broad oceans that water

* Poseidan was the lord of the sea in Greek mythology. Poseidan was also known as the earthshaker, as he could grasp waves and even raise islands to the surface.

** In Greek mythology, Styx is the name of a river which formed the boundary between Earth and the underworld, Hades. is the conduit to Hades, is associated with our passage beyond the borders of life. For the earliest seafarers, this link was all too real. Death at sea has a special, mythical status: the drowned pass on to an altogether more fathomless fate than those whose corporeal being is returned to the shallow Earth. In ancient cultures, children who died in birth were often carried to the river or the sea for fear that their disease would harm the fertile ground. Our enduring fascination with the doomed Titanic (more to read later), taps into this rich seam, while disasters far worse have faded to obscurity.

Water is the agent of geological, environmental, and global change. It confers fecundity in parched regions, while its passing turns grassland to desert. It spells the difference between blue skies and gray. The ebb and flow of oceanic heat bring peculiarities and extremes in climate, the benevolent warmth of the Gulf Stream, the jumpy pulse of El Nino* events which threaten drought or downpour depending on where you are, even the transition to ice-age conditions.

Ice itself may be not just the harbinger but part of the very cause of these glacial spells, during which the Earth is refrigerated for thousands of years. For all its fluidity, water is also one of the main shaping agents of nature. It makes rugged corrugations in highlands, craving out the intaglio of river valleys. It eats away at coastlines to generate under-hangs and caves and eventually to collapse them, and to shift entire beaches down the coast. On its course from mountain to sea it may leave exquisite rock sculptures in the path. Cycles of freezing and thawing split apart the firmest of rocks, reducing slopes to rubble or heaving up stones from beneath the ground in fantastic geological "fairy rings." And in tongues of ice, water scours the Earth into broad valleys and shifts huge boulders over great distances. Water is what makes our planet unique.

Every day, every passing second, water is on the move (Job 6:15-17). The rivers flow, the oceans perform their slow and elegant gyrations, the clouds congeal and weep. *Each 3100 years, a volume of water equivalent to all the oceans passes through the atmosphere, carried there by evaporation and removed by precipitation.*

Yet only a thousandth of 1 percent of the planet's total water resides in the atmosphere at any moment, enough to deposit just one inch of

*El Nino is the warming of sea-surface temperatures in the equatorial Pacific Ocean which influences atmospheric circulation, and consequently rainfall and temperature in specific areas around the world.

rain if it all fell uniformly throughout the world. This constant overturn of water between the reservoirs on land, in sea, and in sky is called *the hydrological cycle,* and it is as crucial for life on Earth as is the presence of liquid water in the first place.

Most of the water that falls as rain has found its way into the sky from the sea surface: the sun's heat removes from the oceans the equivalent of three feet in depth each year, 325 cubic km in total every day. A further 68 cubic km evaporates each day from the land surface. Of course, the rate of evaporation varies widely with the seasons and with geographical location: because the tropics are warmer, the rate of evaporation there is at least four times greater than at the poles.

Evaporation from the ground and from plants, a process known *as transpiration,* removes water to the atmosphere, while precipitation, generally as rain and snow, supplies it to the land. The difference between precipitation and evaporation defines the amount of fresh water available for lakes, streams, and other reserves on land. This "runoff", which is mostly returned to the oceans through rivers, adds up to about 40 cubic km globally per day. In deserts, evaporation is about equal to precipitation and there are essentially ends up as runoff, and most of this finds its way into *the great Amazon River, which delivers an awesome one-fifth of the total freshwater input to the global oceans.*

The various cogs of the hydrological cycle turn at a wide range of speeds. Rainfall in a river's upland source region can take weeks to reach the sea, while water vapor evaporated from the sea surface typically takes about ten days to fall again as rain. For, water locked up as ice (in the so called cryosphere), the cogs may grind slowly indeed. The water at the base of the polar ice sheets has typically been frozen for hundreds of thousands of years. Most mountain glaciers melt and recede by several miles every decade under present-day conditions, while the sea ice in the polar sea expands and retreats seasonally.

The very existence of a hydrologic cycle is a consequence of water's unique ability to exist in more than one physical state, solid, liquid, or gas, under the conditions that prevail at the surface of the planet. Volcanic areas excepted, the Earth's surface never gets hot enough to boil water; but it evaporates readily nonetheless, since the amount of water vapor in the air is generally well below the "saturated vapor pressure", the maximum humidity of air before water droplets start to condense. That's why the oceans are, to a greater or lesser degree, always steaming." When moist air cools, the water vapor may condense back to the liquid state, producing the pearly billows of clouds or the dank blankets of mountain mist.

This cycle of evaporation and condensation has come to seem so perfectly natural that we never think to remark on why no other substances display such transformations. Almost all of the non-aqueous fabric of our planet remains in the same physical state. The oxygen and nitrogen of the air do not condense; the rocks, sands, and soils do not melt or evaporate. If these substances are transformed at all, it is often through the agency of water which will dissolve many gases and minerals alike. The freezing of water, meanwhile, can send it on a millennia-long detour from the cycle of evaporation and precipitation. Yet the ability of water to enter the solid state is also a crucial aspect of the overall cycle. *When water is frozen during the ice ages, the world's seas recede, the climate becomes drier, deserts expand, and ecosystems may be utterly transformed.*

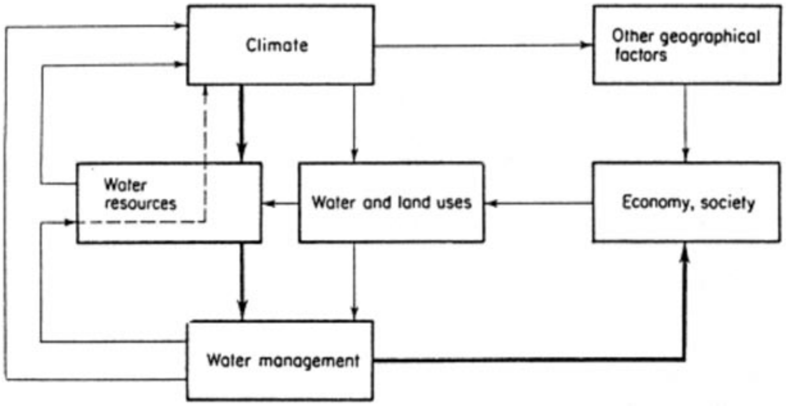
The hydrologic cycle emphasizes the dynamic nature of the Earth's environment: it is constantly repeating and renewing itself. Substances other than water are cycled be geological and biological processes too. Carbon from atmospheric carbon dioxide gets woven into the fabric of plants, may be thence consumed by animals, settles as dead organic debris to the ocean floor, is carried into the deep Earth at the convergence of tectonic plates, and is recycled into the atmosphere by volcanic emission of gases.

Nitrogen from the air is converted back to the nitrogen molecules of air by other microbes feeding off dead organic matter. *These cyclic sequences of chemical and biological transformation of the elements are called biogeochemical cycles.* Water is the lubricant for biogeochemical cycling. Because it is such a superb solvent, and because it is itself in constant flux, it helps to convey other substances hither and thither, between different ecosystems and different climates.

Carbon dioxide in the atmosphere dissolves in the surface waters of the sea to provide a carbon source for—marine photosynthesis, and in turn the biological growth in the ocean's upper layer drives the rest of the ocean's carbon cycle. Essential nutrients pervade the seas in soluble form—nitrate, phosphate, sulfate, and metals such as iron. The swift churning of the hydrological cycle helps to drive the cycling of these other substances: rain and rivers flush inorganic nutrients out of the minerals of the rocky Earth and carry them to the sea. There is little exaggeration in saying that it is water, in the end, that makes the world go round.

Water and Climate

It begins over the Caribbean, or in Australia, it is called a "hurricane," but in other parts of the world it has different names. They know it as a "tornado" in the central parts of the U.S—as a "cyclone" if it begins over the Bay of Bengal, and—as a "typhoon" in the western Pacific. These words describe a extremely violent climatic events. The Earth's atmosphere and oceans rotate as the Earth itself rotates on its axis, and at the same rate. This gives them all an *"angular momentum,"* which has a value that can be calculated by multiplying together the mass of the body of air or water being considered, the radius of its orbit, and the square of the rate of spin, known as the *"angular velocity."* The total angular momentum must remain constant, if the system as a whole is to maintain a constant angular velocity, so, if one component of angular momentum changes, the other components must compensate. As heat is transferred from low to high latitudes, bodies of air and water, functioning as media for its transport, that move as discrete entities, cannot do so in a straight line. The further they move from the equator, the more strongly they will move eastward.



Above high altitudes, in the subtropics and again in middle latitudes, sharp differences in temperature between air masses generate jet streams, irregular, fast-moving, westerly streams of air, with speeds of 160 to 240 km per hour, and in winter times reaching 480 km per hour. The middle-latitude jet streams tend to drive low-level depressions in an easterly direction, and this is another reason for the tendency of weather systems to move from west to east.

It accounts for the different climates that have traveled across the continent, while in the same latitudes the western coast of Europe receives weather that has crossed the Atlantic. It is not simply the humidity of the air that is conditioned by its contact with the oceans or dry land, but also its temperature. Water has a much greater capacity than dry land for storing heat.

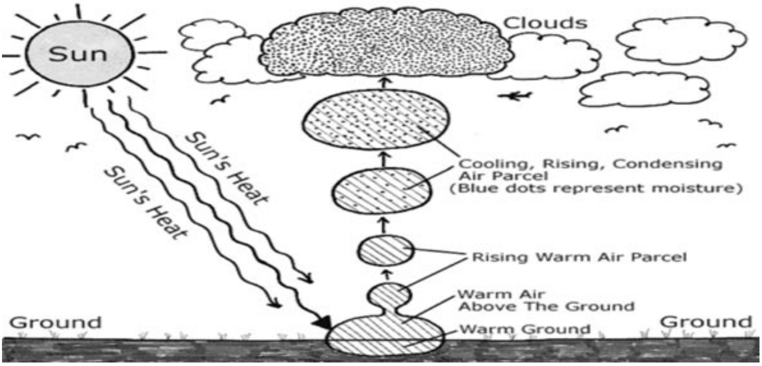
This quality has nothing to do with the fact that water occupies a much larger surface area of the planet than does dry land, although this obviously determines the magnitude of the effect. The quality belongs to water itself and drives from its specific heat.

Formation of Clouds

As spray is whipped up by the wind, some of its water droplets fall back into the sea, but some evaporate. This leaves behind very small, airborne, salt crystals. These crystals are of a size and shape suitable for water condensation, and they provide some CCN, but nothing like enough to account for the amount of cloud over the ocean. The other source, and probably the principal one, is the marine phytoplankton. For reasons that are not really understood, but which may be connected with the regulation of salt levels inside cells, many species of plankton excrete a compound called dimethyl sulphide.

Some of this enters the air and is oxidized in a series of reactions, and one of the reaction products is sulphate, SO3, which exists as small crystals. Sulphate crystals are also effective CCN. In recent years there has been a marked increase in the amount of phytoplankton in the seas and oceans, the algal blooms that have caused concern in the North and Adriatic Seas are part of this phenomenon, but there are also large blooms in the Atlantic.

Raindrops that have condensed on to sulphate reacts with water, it becomes sulphuric acid. Marine planktons are one of the major causes of "acid rain."

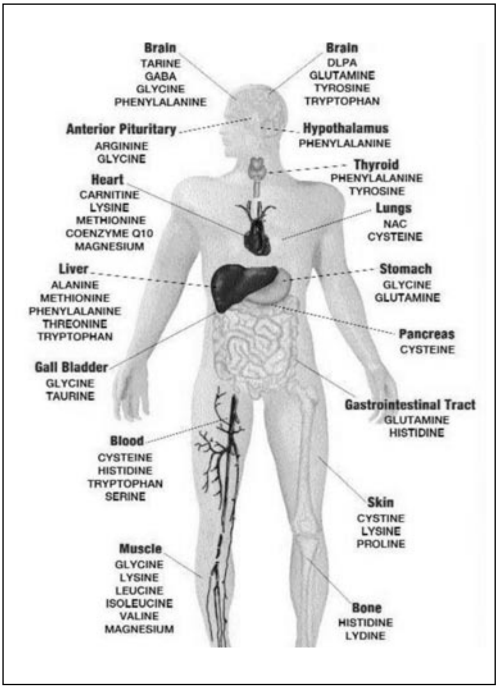


Sulphate crystals also occur over land, as a result of burning fuels that contain sulphur, and the consequent release of sulphur dioxide (SO2). Some climatologists who are calculating the consequences of "greenhouse effect" warming have warned that reducing the amount of carbon-based fuel we burn and, therefore, the amount of carbon dioxide we release into the air, may have less effect than we suppose because it will also reduce the quantity of sulphur dioxide emitted. This, they suggest, will reduce the amount of cloud and precipitation, which probably have a cooling effect, while increasing the average humidity of the air.

The Circulatory System

The blood is a kind of all-purpose medium. The transport nutrients to cells and wastes from them, destroys alien cells and, of course, it delivers to tissues the compounds that will react to provide energy where it is needed. Cells obtain the energy they need by a complex series of chemical reactions. In most plants and animals, several of these reactions involve the oxidation of compounds, so oxygen is needed, and yield carbon dioxide as a by-product which must be removed. The overall process is cell, or tissue, respiration and the act of breathing is the means animals employ to obtain oxygen from the air and rid their bodies of carbon dioxide. The oxygen and carbon dioxide are conveyed to and from bodily tissues by the red blood cells, known technically as *"erythrocytes."* The erythrocytes are red because they contain the "respiratory pigment" haemoglobin, which is red. This consists of two pairs of "polypeptides," long molecules each of which is made up of many amino acids joined each to end in a chain. These chains comprise the globin, and each of them is folded in such a way as to provide a site to which a molecule of haem is attached, a large molecule that includes one atom of iron. The iron can be oxidized, converting the haemoglobin into oxyhaemoglobin, but the bond is weak. If a nearby molecule is depleted of oxygen, it will attract the oxygen atom away from the haem. One fluid ounce of blood contains about 128 million eryhrocytes and blood can contain oxygen equal to about one-fifth of its own volume. This is about 60 times more oxygen than will dissolve in an equivalent volume of water.

Body fluids taste salty. Some people entertain the romantic notion that this is because the evolution of life began in the marine environment where the salinity inside and outside cells was much the same, and their land-dwelling descendants have retained this feature. The composition of our body fluids is thus a relic of an ancient ocean. Sodium, potassium and chlorine are essential ingredients of all cells because of the electric charges their ions carry in solution. They are involved in the movement of molecules into and out of cells, for example, and sodium is necessary for the building of proteins and for cell division. *Body fluids taste salty because they contain sodium chloride, but it is pure coincidence that sea water is also salty.* Sodium also plays a vital role in the "sodium pump" mechanism by which urine is concentrated in the kidneys by extracting water from it. You might picture the body of an animal as a water container, but it is a leaky container, and some animals are more efficient than others at holding water. A cat needs to drink, but in relation to its size it drinks much less than a human. We are very leaky animals, mainly cause we perspire more efficiently than most animals, using the latent heat of evaporation of water to prevent ourselves from over-heating in hot weather.



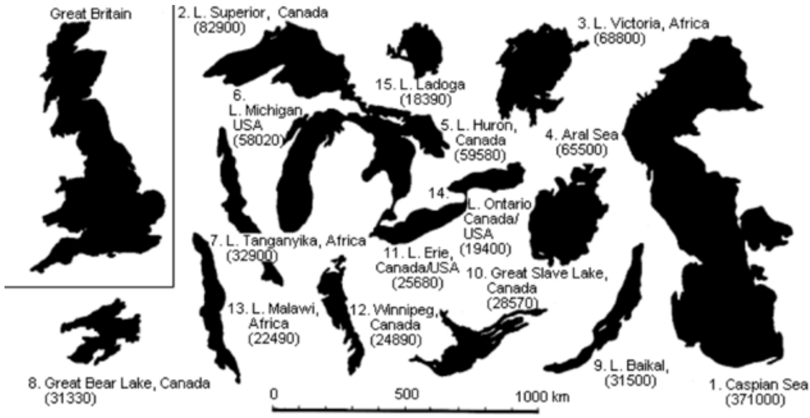
Some desert animals do not drink at all. They obtain all the water they need from the plants they eat and then retain it. The sodium pump, which is an adaptation to life away from the water, helps them in this. In humans, the sodium pump adjusts the concentration of urine that is excreted according to the concentration of the urine when it enters the kidney. The less dilute the urine, the more the kidneys concentrate it to conserve the little water it contains. A person who drinks ample amounts of fluid will excrete copious quantities of dilute urine. Someone whose body is dehydrated will excrete much smaller amounts of much more concentrated urine.

A human cannot survive for very long without water to drink, because, although our kidneys can help reduce water loss, they cannot prevent it. Each time we exhale, the breath leaving our lungs carries water from the moist tissues lining our respiratory passages, you can see it condense if you breathe on to a mirror, even in the driest weather, and while we may keep ourselves cool to reduce perspiration, there is nothing we can do to prevent ourselves breathing. As water continues to leave the body, the concentration of the body fluid solution increases until water starts to drain from cells by osmosis.

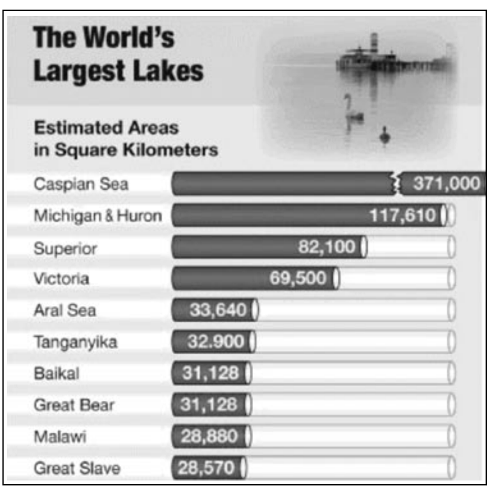
Lakes – Our Blue Little Worlds

Lakes contain about 90% of all the surface fresh water found on Earth. Lakes form when water finds its way into a basin. In order to continue existing, lakes must have a continual source of new water otherwise they will eventually dry up. Most lakes contain fresh water. However, in some cases, the water found in a lake can become salty, just like the ocean. This happens when a lake does not have a stream, either above ground, or underground draining water away from it. As water enters a lake, it carries minerals with it.

As this water dissolves, it leaves the minerals behind. Most lakes only last a few thousand years, and then disappear. This is because as streams and rivers carry water into the lake, they also carry sediment. This sediment slowly fills the lakes, causing them to become shallower. At the same time outbound streams cut deeper and deeper channels, causing the lakes to drain more quickly. Many lakes are man made. These are referred to as reservoirs. Reservoirs allow cities and nations to store water for later use. Most of these reservoirs are small in size, but some are very larger, spanning several hundred miles.



The biggest lake in the world can be classified in a number of different ways. We have chosen to classify the biggest lake according to the amount of water it contains, but will make honorable mention extremely large lakes by square kilometerage. The biggest lake, by volume, in the world is Lake Baikal in Russia at almost 24,000 cubic kilometers. It contains 20% of the world's supply of fresh water and has more water than all of the Great Lakes of North American combined. It can reach depths of almost 1700 meters at points and has been declared a UNESCO World Heritage Site. The Caspian Sea is the biggest body of water inland by square kilometers; however, with a salinity of about one third of sea water, some think of it, as a sea. It has 78,000 cubic kilometers of water. *The biggest, completely fresh water lake in the world is Lake anganyika in Africa at almost 19,000 cubic kilometers.* This lake is so large that it borders four countries—Burundi, Democratic Republic of the Congo, Tanzania, and Zambia. Both Lake Baikal and Lake Tanganyika were formed in rift valleys and therefore both are long and crescent shaped. Some of



the world's largest lakes by surface area are Lake Victoria, almost 69,000 square kilometers; Lake Huron, almost 60,000 square kilometers; and Lake Michigan, almost 58,000 square kilometers.

Deep Blue Oceans and Seas – Terra Incognita

Around half of the Earth's solid surface is between 1.8 and 3.6 miles below sea level: the places where we live are like the tips of icebergs. The deepest parts of the ocean, the trenches, can plummet about 9 km, well over a kilometer deeper than Mount Everest is high. The floors of the great oceans are scarred down their middle by rugged submerged ridges several miles high.

These mid-ocean ridges mark the borders of tectonic plates: here magma wells up from the mantle, cooling at the sea bed to solidify into fresh ocean floor, while the plates move apart on either side. If all evaporation and transpiration cease suddenly, but rain and snow continued to fall normally, *the amount of water held in the atmosphere would be sufficient to last about 10 days, during which it would deliver the equivalent of 1 inch of rain distributed over the entire surface of the planet.*

Almost all of the Earth's water is contained in the oceans, and a small amount as ice, but very little indeed exists in the gaseous phase or as the airborne droplets that comprise clouds. At anytime, 97% of all water is in the oceans. Of the 3% that exists as fresh water, 75% forms the Polar ice sheets and glaciers. Between them, lakes and rivers contain about 0.33% of the fresh water, the soil about 0.06%, and the atmosphere contains only about 0.035%.

That we receive a significant amount of rain and snow, that the sky is often completely covered by cloud, and that the speed with which water is transferred between land and sea. Another way to describe the 10 days' supply of rain and snow in the atmosphere is to say that, on average, a water molecule that enters the atmosphere will remain there no longer than 10 days. The movement of water from the oceans and land surface into the air, and its return to the oceans by direct precipitation and from rivers, forms the *"hydrological cycle."* Over the world as a whole, each day about 875 cubic kilometers of water evaporates from the oceans, and about 160 cubic kilometers evaporates or is transpired by plants from the land surface.

This is the water vapor that enters the atmosphere, a total of about 1035 cubic kilometers a day. Every day about 775 cubic kilometers falls as precipitation over the oceans and about 260 cubic kilometers over the land, and about 100 cubic kilometers is returned to the oceans by rivers. This is the cycle but, of course, it is much more variable than so general a description makes it sound. The amount of water involved varies according to the season, for example, because more water evaporates in summer than in winter. This means that in summer the air carries more water even though the amount of rainfall may be less. The seasonal difference is considerable. Evaporation is obviously much less from the interior continents than it is over the open sea, and the amount of precipitation varies widely, from the humid tropics to the most arid deserts, and these two extremes often occur within a short distance of one another.

Four Major Oceans

In order to aid scientists in studying and understanding the vast seas of the Earth, researchers generally divide them into four distinct oceans. *These oceans are the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, and the Arctic Ocean.* As you can see in the picture, these oceans are connected, forming one large ocean.

Water from one of the four oceans is free to move into another ocean. Whales, fish, and other life forms from one ocean are free to travel to another. We humans and other land animals have limited land territory, having just 25% of the planet's surface. But whales and fishes have 3 times larger territory than us. In addition to these four oceans, a number of seas, bays, and gulfs have also been designated as seas. These are generally just smaller portions of one of the larger oceans, though in some cases, such as the Mediterranean Sea, they are almost completely cut off.

Pacific Ocean – By far the largest of the four oceans, the Pacific covers nearly one-third of the globe, an area approximately 105 million square km, more than 10 times larger than India. The Pacific Ocean is immense. All the continents could be placed into it, and there would still be room left over. Even with the many topographic features found on the sea floor, such as plateaus, ridges, trenches, and seamounts, it has an average depth of 13,000 feet. The Pacific is approximately 20,000 km wide at the Equator. This vast body of water extends upward touching the Arctic Ocean, and also extends down to the shores of Antarctica. The bulk of this ocean however lies along the warm tropics. This makes the majority of the Pacific's water warm. *The Pacific Ocean has the deepest average depth, and is also home to the deepest trenches on Earth. Much of the Pacific is dotted with small volcanic islands, such as Hawaii, Tonga, and Samoa. Not only is it the largest and deepest, it is probably the most violent of all oceans. The Pacific Ocean is notorious for bad weather.* Some of the most powerful storms are brewed within its waters. The Pacific Ocean has typhoons in the equatorial regions, nearly 300 active volcanoes which vent steam and smoke on her borders, and tidal waves are periodically unleashed. Unlike the basin floors of the Atlantic and Indian Oceans, the Pacific is characterized by the Central Pacific Trough. This feature extends from the Aleutian Islands southward to Antarctica and from Japan to the west coast of North America. The basin floors are not completely flat and ridges and seamounts abound. Along with a number of deep ocean trenches, the Pacific has many flat-topped seamounts: *Guyots*.* These are rarely found in other oceans.

The Atlantic Ocean – The hourglass shaped Atlantic covers approximately 20% of the Earth's surface and is the second largest of the four oceans. It extends from the North Pole southward for 16,000 km to the Antarctic continent, and covers 41 million square miles. Width of the Atlantic varies from 2,950 km between Brazil and Liberia and approximately 4,800 km between Norfolk, VA, and Gibraltar. This makes it the same size from North to South as the Pacific Ocean. However, from East to West, the Atlantic Ocean is only about half as wide as the Pacific. *The Atlantic Ocean is a deep ocean.* Its average depth is just slightly less than that of the Pacific Ocean. This ocean has far fewer islands than Pacific. More is known of the Atlantic than any other ocean because of heavy commercial and military ship traffic connecting Europe and North America. Average depth is 12,000 feet and the greatest depth is 28,374 feet in the Puerto Rico Trench. If Alaska's Mount Mckinley (20,320 feet) was to rise from the floor of the Puerto Rico Trench, its peak would still be about 1.5 miles below the surface of the Atlantic. The Atlantic houses the biggest mountain range, the Mid Atlantic Ridge.

The Indian Ocean – The Indian Ocean lies between Africa on the west, Australia on the east, Asia on the north, and Antarctica on the south. 90% of this ocean lies to the south of the Equator and it is very productive. The Indian Ocean is just slightly less deep than the Atlantic Ocean. The Indian Ocean is often thought of incorrectly as a tropical ocean. Check your map! It stretches southward to Antarctica. It is triangular and bordered by Africa, Asia, Antarctica, and Australia. Although it covers about 28.5 million square miles, it is smaller than the Atlantic and less than half the size of the Pacific Ocean. The maximum width is 9,500 km between the southernmost portions of Africa and Australia. The Indian Ocean contains about 20% of the Earth's water surface. Many island nations are found within the boundaries of this ocean such as Madagascar, which is the world's fourth largest island, the Seychelles,

---

*Guyots are volcanoes that have built up from the ocean floor, sometimes to sea level or above. Guyots are seamounts. Erosion by waves destroyed the top of the seamount resulting in a flattened shape.

Maldives, Mauritius, and Sri Lanka. The average depth of the Indian Ocean is about 12,750 feet. The deepest is 24,440 feet in the Java Trench in the extreme northeast corner of the basin. The Indian Ocean, like the Atlantic Ocean is divided by a mid-ocean ridge that separates the basin into nearly equal portions. The ocean's continental shelves are narrow, averaging 125 miles in width except off Australia's western coast where it broadens to 600 miles.

The Arctic Ocean – Arctic Ocean is connected to the Pacific and Atlantic oceans via small gaps between continents. This ocean is also much colder than the other majority of the other oceans, with much of the water covered in a frozen ice cap. Arctic Ocean is centered approximately on the North Pole. *It is the smallest of the world's oceans, covering about 4,732,000 square miles. Maximum depth is 18,050 feet.* The ocean is divided into two nearly equal basins: the Eurasia and the Amerasia. The Lomonosov Ridge extends from northeastern Greenland to Central Siberia and separates basins. The Arctic Ocean is surrounded by landmasses of Eurasia, North America, and Greenland, and is unlike the other three oceans because of the perennial ice cover. The extent of sea ice is seasonal between 60N and 75N latitude, but above 75N it is relatively permanent. Ice cover reduces energy exchange with the atmosphere resulting in reduced precipitation and cold temperatures. A unique feature of the ice fields of the Arctic Ocean was the discovery in 1946 of large sized ice islands. One of the first major ice islands covered an area of more than 485 square km. In later years ice islands were extensively tracked to determine current movement. They were also used as scientific research sites for the study of polar meteorology and oceanography.

Characteristics of Oceans and Seas

The Smell of the Sea - If you plan a visit to the coast, probably you will enjoy looking forward to your first smell of sea air. The sea does have a smell sometimes and it is not the very different smell of ozone that people once imagined. It is a subtle smell, not present everywhere or all the time and, in part, most probably it is diluted dimethyl sulphide. What your nose detects is that stage in the sulfur cycle in which sulfur is being transported from the sea back to the land. Most of the component of the smell that is not part of the sulfur cycle is part of the iodine cycle. Sulfur is absorbed by plant roots from the soil solution as sulphate (SO4) ions. Inside plant tissues the sulfur is incorporated into amino acids and built into proteins. Some of these proteins return to the soil immediately when the plant dies, others are first consumed by animals, which postpone their return, but do not cancel it. When at last the sulfur returns to the soil, bacteria oxidize it back into sulphate which, being soluble, dissolves in the water present in the soil. Each time this happens a proportion is lost bleaching, which makes it available to aquatic organisms. Eventually, as part of the general accumulation of organic wastes, some of the sulfur becomes incorporated in mud on lake beds and river estuaries. Much of it remains there, reacting with metals to form the insoluble sulphides that are common constituents of sedimentary rocks, but some is recycled. Muds are airless places, inhabited by organisms which find oxygen poisonous. They feed on the wastes, and one byproduct of their activity is hydrogen sulphide (H2S) gas. The hydrogen sulphide bubbles out of the mud, sometimes all the way to the surface, and a certain amount of sulfur is returned to the land by this route, with the hydrogen sulphide oxidized to sulphuric acid (H2SO4) or sulphate. You may have detected the unmistakable, *"rotten eggs,"* smell of hydrogen sulphide in the vicinity of stagnant ponds or mud.

The Salinity of the Oceans - The salinity of the oceans varies only slightly. Close to the Equator, where rainfall is high, the average salinity is about 34.5 parts per thousand. In the subtropics, around latitudes 20 degrees north (India) and south, where rainfall is light, but evaporation intense on land, this is the belt that includes the major deserts it rises to about 35.8 parts per thousand. At higher latitudes it falls again to around 34.0 parts per thousand.

The situation is much more complicated where rivers flow into the sea and fresh and salt water meet. The two bodies of water are less dense than salt water. Fresh water is less dense than salt water. In most estuaries it is also warmer in summer, but colder in winter. The fresh and salt waters are slow to mix, especially in summer. This is the basis of the controversy over the discharge of sewage into the sea. Were the two water bodies to mix readily, the sewage would vanish as it dispersed rapidly over a wide area. The sewage is essentially fresh water, however, and tends to rise to the surface, with very little mixing, and wind or tide may carry it back to the shore. In some estuaries, the incoming tide forms a "salt wedge" beneath the outgoing river water, allowing marine fishes to move upstream in the salt water. In others, distinct streams occur, moving outwards and the tide inwards.

Ocean Water – The Ocean can extend in some places down to depths of several miles. However, most of the action takes place in the first couple hundred feet. Below this depth it is too dark, cold and murky for much to happen. Across the entire planet, the Earth's oceans are believed to be basically the same below the first couple hundred feet. Above the depth, where sunlight reaches, the traits found change dramatically from one location to another. Characteristics such as temperature, turbulence, and salinity can be very different from location to location.

Ocean Waves – The surface of the Earth's Oceans is in constant motion, moving up and down, in the form of waves. If you have been to a beach, you have witnessed waves first hand. Waves form, as energy is transferred from molecule to molecule across the surface. In general, the water molecules move very little. It is only the energy that actually moves. However, as waves break across a shore or crash in violent storms, they can be the source for great mixing of an ocean's water.

Ocean Currents – There are a number of ocean currents found around the Earth. A current is like a vast river within the ocean, flowing from one place to another. These currents are caused by differences in temperature, differences in salinity, and by wind. Currents are responsible for a vast amount of movement of the water found in the Earth's oceans.

Ocean Tides – By far the most important factor, effecting the movement of water across the ocean are tides. Tides are great bulges of water, caused by the gravity of the Moon, and sun. Attracted by gravity, these bulges move around the Earth's oceans, causing water levels to

*An atoll is a type of low, coral island found in the tropical ocean consisting of a coral-algal reef surrounding a central depression. The depression may be part of the emergent island or part of the sea, that is, a lagoon, or more rarely an enclosed body of fresh, brackish, or highly saline water.

rise and fall. Typically water will rise for about six hours, followed by six hours of falling water depths.

The Earth's Ice – Second only to the ocean in the amount of water storage, the ice of the Earth makes up more than twice as much water as all other types of water storage, including ground water, lakes, streams, etc. it has been estimated that there is enough water locked up in the form of ice to sustain all the rivers and streams of the Earth for nearly 1,000 years. This ice is found around both the north, and south poles, and is always fresh, regardless of whether it formed by freezing rain, or sea water. The salt is not taken into the ice crystals as they form. In addition to the vast ice caps found at the top and bottom of the Earth, there is also vast amount of frozen water underground. This frozen soil is known as permafrost, and is found in Canada, Alaska, and Siberia.

Corals and Atolls*

There are about 300 atolls in the Indian and Pacific Oceans, but only about 10 in the Atlantic. Gaps occur in the reef, permitting access to the lagoon, and parts of the reef may protrude above the surface as islands, the islands of Bermuda are part of an atoll. A reef of this type does not have to project above the surface to be called an atoll, and most atolls are submerged. Small reefs, of irregular shape or sometimes circular, which occur inside lagoons are called "patch" reefs, and small reefs, without lagoons, that occur in the open sea, are "table" reefs. *A coral reef forms below the surface of the sea but, over long periods, the sea level changes as a result either of climate change or of movement in the crustal plates*. Should the sea level rise, a reef can grow upwards, but, should the sea level fall, the uppermost parts of the reef may be exposed.

The reef organisms die and that part of the reef becomes dry land. If there is a supply of fresh water, eventually it will be colonized by land plants. If not, it will be a true desert island. It is the gradual rise in sea level since the end of the last ice age that has allowed reefs to grow to their present height, and the height of coral reefs is used as a measure of sea-level change. Test drilling has penetrated the Great Barrier Reef to a depth of more than 700 feet without reaching bedrock. On its seaward side, a reef has long "fingers" projecting forwards and separated by "valleys." The gradient varies as the height of the reef increases to a crest, and behind the crest (the back-reef) it often slopes gently downwards, with water channels and small pools of calm water. The structure is complex and provides habitats of many kinds, supporting different types of coral.

The coral itself is constructed by animals related to, and not unlike, sea anemones, but usually much smaller. The phylum to which they belong (Cnidaria) comprises animals with life cycles that take them through two distinct forms, a medusa (like a jellyfish) which then settles in one place as a "polyp."

Some members of the phylum have abandoned one or other stage in the life cycle. The familiar jellyfish never become polyps, and the animals that build coral live only as polyps. Each individual polyp is like a tube, enclosing the cavity in which food is digested, sealed at the lower end and having a mouth surrounded by tentacles, some of which sting at the upper end. The body secrets a casing, made of calcium carbonate, in which the animal lives. *Some coral polyps are solitary and up to 10 inches in diameter, but those which build reefs live in colonies of millions and are no more than 0.04 to 0.12 inches in diameter.* The "skeleton" is secreted by the lower half of the body of the polyp and at its base, and each polyp is connected to its neighbors by a sheet of tissue across the top of the casing. Sometimes polyps reproduce sexually, and the progeny settle down to found new colonies. Within the colony, the polyps reproduce by budding, one individual divides into two, the way it does so varying from one species to another and in many species the polyps lift themselves up from time to time and secrete a new base, sealing off a tiny, hollow area. This is how reefs grow.

Scientists have estimated that coral reefs may grow thicker at a rate of about 0.6 inches a year, although erosion removes nearly as much calcium carbonate as is added, and that reefs may occur where calcium, carried from the land by rivers, tends to accumulate. Inside their body cavities, almost all reef building polyps have colonies of single-celled algae called—*"zooxanthellae."** These contain chlorophyll and other pigments which together give the corals a generally yellowish-brown color. Photosynthesis by its "zooxanthellae" contributes nutrients to the coral polyp, and the polyp augments this with the food it catches with its tentacles anything from plankton to small fishes depending on the size of the polyp. Wastes from the digestion of this food contain nitrogen and other elements, which are used by the zooxanthellae. *The polyp and zooxanthellae cycle food back and forth between them and the system is very efficient indeed.* The activity of the zooxanthellae also stimulates the secretion of skeletal material probably by removing carbon dioxide from the water. By removing carbon dioxide, the zooxanthellae allow the reaction to continue, in effect they drive it and this produces a steady supply of calcium carbonate. The construction of a reef begins with the formation of the skeleton. As it grows, unevenly, the flow of water around it is altered and some areas are more sheltered than others. These differences provide suitable conditions for other coral species, including very small, delicate corals, which form secure links between larger blocks, cementing them together. A mature reef may comprise many coral species there are more than 200 forming the Great Barrier Reef. Some are massive, but others resemble fans, or form the most delicate traceries.

The Coral Ecosystem

Corals produce food and attract predators. It is only other corals that are attracted, however, and no sooner has a reef started to grow upwards than it comes under attack. Sponges and mollusks bore holes into it, sometimes from below so they undermine it but, as they bore, these organisms are constantly excavating fine material that accumulates around them and eventually may bury them. The crown-of-thorns starfish, a Pacific species, feeds on polyps and from time to time its numbers increase dramatically. This damages the coral, but it also provides food for animals that feed on the starfish, such as a marine snail called the giant triton and painted shrimp. Exposed surfaces also provide sites

*Zooxanthellae are symbiotic single-celled plants which are related to the free-living planktonic dinoflagellates. They live in the tissues of many marine invertebrate animals, including giant clams, nudibranchs and flatworms, but they are best known for their association with cnidarians, and in particular the reef-forming corals, which would be unable to build their calcium carbonate skeletons without the nutrients provided by their zooxanthellae.

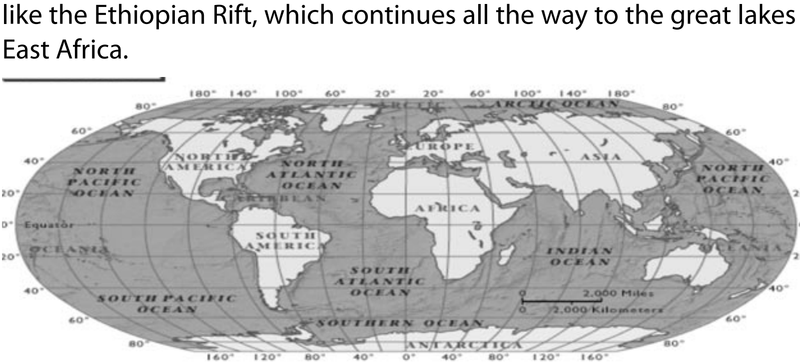
on which other algae can grow, especially filamentous green algae so, in places, the living reef will be green because it is blanketed by plants. Fishes feed on the plants, and are hunted by other fishes, *but it is the plants, which make up most of the living material. The green algae are more abundant than the zooxanthellae, and altogether the mass of plant material is usually about three times that of the animal material.* A relationship between two species in which each partner benefits from the other is called—*"symbiotic,"* and the partnership between the coral polyps and their zooxanthellae is one of the clearest examples of a—symbiosis. *Because the zooxanthellae use photosynthesis to convert simple compounds into sugars, they form the base for a food chain similar to the base provided by green plants on land.* In ecological terms they are—"primary producers" and, because they form an integral part of the coral, the coral itself may be regarded ecologically as a primary producer.

As well as being a producer, the coral is also a—*"primary consumer,"* a herbivore, occupying the same position as, say, a rabbit on land, because it utilizes the sugars produced by its zooxanthellae, it digests the algae in its body cavity. An animal that obtains food by eating other animals is called a—*"secondary consumer,"* and the coral is also a secondary consumer because, in addition to digesting algae, it feeds on zooplankton, the tiny animals living among the plankton. The polyps are usually inactive during the day keeping their tentacles withdrawn, and feed on zooplanlton at night. The zooxanthellae photosynthesize during the day and are inactive at night. This complex system provides food for others. The algae on the coral surface, which in places grow to a large size and almost hide the coral beneath dense thickets of waving fronds add to the primary production. The algae are grazed by other herbivores, including sea urchins, brittle stars, mollusks and some fishes. Other mollusks are carnivorous, and so are some groups of worms, such as the "Christmas tree worms."

These animals bore into the coral surface to make the tubes in which they live, and feed by filtering zooplankton from the water with their tentacles that are shaped very like the branches of a fir tree. Many of the fishes are also carnivorous. Apart from the pretty ones, the rich feeding grounds of a coral reef are patrolled by most species of sharks. At the end of the food chain there are the decomposers, the fish species such as the blennies that live on the wastes suspended in the water, and bacteria, which break down large molecules into smaller, simpler ones, ready to be taken up again by the plants. A coral reef is very stable and its natural lifespan is long. *The Great Barrier Reef began growing some 10 million years ago, when part of the Australian continental shelf subsided.* Other reefs, built by species long since extinct, are known to have existed about 500 million years ago. Reefs may be damaged naturally, by hurricanes or sequences of unusually low tides, but they recover. *Whether they can survive human disturbance is less certain.*

Life Cycle "of" Oceans and Seas

The Red Sea is one of those almost landlocked seas, and its waters, at about at about 37 parts per thousand in the south and about 41 parts per thousand in the north are more saline than those of the Indian Ocean, to which it is linked through the Gulf of Aden. We tend to think of the seas as eternal, but until about 20 million years ago the Red Sea probably did not exist. *Seas, and oceans, have life cycles. They are born, grow, age, and eventually they disappear. The Red Sea is very young, and it is still growing.* One day, a long time in the future, it will rank as an ocean, separating the Arabian Peninsula from the continent of Africa. According to Tuzo Wilson, Professor of Geophysics at the University of Toronto and one of the leading authorities on the subject, the life cycle of an ocean, know as—*"the Wilson Cycle"* has several distinct stages. It begins when great blocks of the Earth's crust are lifted up and moved apart, forming a *"Rift Valley"* between them into which water will enter if there is a link to an ocean. The base of the valley then subsides and widens further, forming a narrow sea with parallel sides, like the Red Sea. A valley of this kind often has a "triple junction" a place where one valley divides into three. Two of these smaller valleys may widen, like the Gulf of Suez and the Gulf of Aqaba, while the third forms a long extension called an *"aulacogen,"** like the Ethiopian Rift, which continues all the way to the great lakes of East Africa.



*Aulacogen is classic failed continental rift. In short it is an uncompleted rift.

The sea continues to widen, forming an ocean basin bounded by continents, until it becomes unstable. When that happens, part of the basin, well away from the center, sinks back into the Earth's mantle. This produces a deep ocean trench and, associated with it, an arc of islands. This process continues as, little by little, the ocean floor sinks, is "subducted" back into the mantle. Finally, the entire floor disappears and the continents to either side collide. The Red Sea is at an early stage in its life cycle, and only about 20 million years old. *The Atlantic Ocean is about—200 million years old, and—still growing, and the Pacific Ocean is now—distinctly elderly, and shrinking.* These ages, measured in millions or even hundreds of millions of years, sound immense and so far beyond ordinary human experience as to be unimaginable. In the history of the planet, though, which is measured—in thousands of millions of years, they are brief and oceans are emerging, changing shape. Even on the human scale, the rate of movement is considerable. The North Atlantic, for example, is growing wider by about 1 inch a year by a curious coincidence, exactly the rate at which human toenails and fingernails grow. When next you trim your nails, the amount of nail you remove is equal to the distance Europe and North America have separated since you last trimmed your nails! Over the course of 200 million years, the Atlantic has widened to about 4800 kilometers at this apparently slow rate.

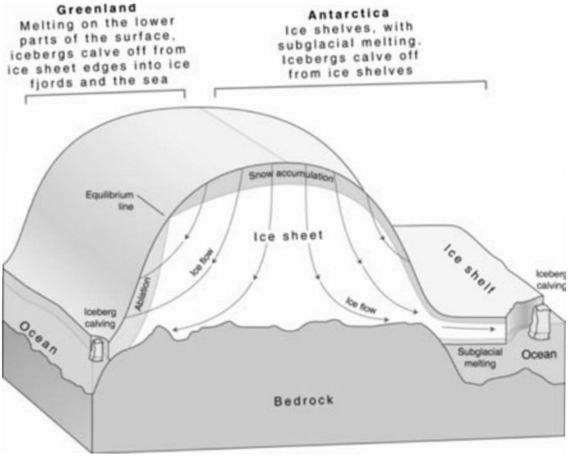
Formation of Ice Sheets

An ice sheet forms by the accumulation of snow, and not by the freezing of water at the surface. As snow falls on top of snow, the weight gradually compresses the lower layers until the loose crystals are packed together tightly to make solid ice. The process is similar to that by which sediments begin to be converted into sedimentary rock and quite unlike the process by which we freeze water to make ice in a refrigerator. Today, the largest ice sheets are in Antarctica, and they contain about 90 percent of all the ice in the world.

The ice sheets are not continuous, and there are ice-free areas, but the average thickness of the ice is about 2 kilometers, and its total volume is about 30 million cubic kilometers. *Were all of that ice to melt, the sea level throughout the world would rise by some 250 feet.* At various times in the past, the Antarctic ice sheets are estimated to have been 1000 to 2000 feet thicker than they are now. The only substantial ice sheet in the northern hemisphere is that which covers about 85 percent of the land area of Greenland. With a total area of just over 1.8 million square kilometers, and an average thickness of about 5000 feet, it represents a volume of about 2.8 million cubic kilometers of water. Its melting could have major impact on the sea levels.

Although ice is clearly a solid, when it exists on this scale the pressures, to which its own weight subject it, cause it to behave like a very viscous liquid. It can be squeezed from the base of the sheet into any suitable rock fissure, and where it is squeezed into a structure that can be made into a valley, it becomes a moving glacier.

The glaciers of Greenland flow to the sea, like rivers, where the ice melts or breaks off in large pieces, icebergs. Glaciers flow slowly, but some of those in Greenland move at up to 100 feet in 24 hours, which is considered very fast, at 0.8 inches per minute, the ice moves at about the same speed as the tip of the minute hand on a clock that has a face about 16 inches in diameter. When you see around you the evidence of former ice sheets, and wonder what the countryside looked like under glacial conditions, modern Greenland is an excellent example, Europe and Asia, to about as far south as Prague, once lay beneath the Siberian ice sheet, and North America, south to about St. Louis, lay beneath the Laurentide ice sheet.*



*The great glacier complex over North America during the late Wisconsin consisted of two separate sheets. The larger actually formed as two separate nuclei; one to the east and the other to the west of Hudson Bay. These two centers of glacial accumulation coalesced to become the Laurentide Ice Sheet

These lands looked as Greenland looks today, with ice 5000 feet thick and there is reason to suppose that in some places it was twice that thickness. The regions bordering the ice sheets to the south supported only tundra vegetation. Still further south lays great coniferous forests, like those of modern Canada and Scandinavia. The ice sheets of the southern hemisphere were also much larger once than they are now, although their expansion was smaller than that which occurred in the northern hemisphere. *The formation of an ice sheet involves the removal of water from the oceans, by evaporation, and its precipitation as snow.* Once precipitated, it accumulates because its rate of return to the ocean and atmosphere is much lower than the rate at which it is delivered. Some does return to the ocean, by the melting or "calving" of glaciers to produce icebergs, and to the atmosphere, by "ablation," the evaporation of surface ice melted by solar warmth, or by its direct change from the solid to gaseous phase called "sublimation." *The steady transport of water from the ocean to the ice sheet causes the sea level to fall. When the ice sheet melts, the water returns to the oceans and the sea level rises again*. The theory explaining the process is called "glacio-isostasy."* A major episode of this kind may alter the sea level by up to 330 feet.

This is a fairly rapid process, in the sense that the sea level responds at once to the removal or addition of water, but there is a second process at work, called *"glacio-isostasy,"* which is much slower and has an opposite effect. The weight of a large ice sheet depresses that part of the lithosphere on which it rests, so that while the removal of water from the oceans causes the sea level to fall everywhere, the land beneath the ice is sinking. This will not be immediately evident, because the thickness of the ice is growing, raising its surface, but its effects are felt when the ice finally melts, because then, fairly slowly, the land rises again, eventually to its former level. It is estimated that Scandinavia sank by about 3300 feet under the weight of its ice sheet and since the ice melted it has risen by about 1700 feet. It is still rising, and so is Scotland. In high latitudes, where snow falls every winter and melts for a short time every summer,

*The eight of the ice sheet depressed the Earth's crust. At the same time, because so much water was contained in the ice sheets and glaciers, the ocean level was lower. Then, the ice retreated. In some parts of Atlantic Canada, far from the center of the ice sheets, sea level rose. In other places, closer to the ice, the Earth's crust rebounded when the weight of the ice was removed, so that sea level dropped for a while. Eventually, the rising ocean level caught up with the rebounding crust, so sea level rose. The result: different histories of sea-level change in different places.

a slight fall in summer temperatures might prevent the seasonal thaw. Were this to happen, the snow from one winter would persist until the next. Freshly fallen snow has a—high albedo, it reflects almost all of the sunlight falling on it. This allows it to absorb little warmth, so it tends to endure, and by chilling the air in contact with it, the air temperature is reduced around its margins, so it tends to spread. Under these conditions snow would accumulate, and a continuation of the process would lead to the formation of an ice sheet. This is what is believed to happen at the onset of—*an "ice age,"* and many scientists believe it can happen rapidly once it begins because of the strong element of positive feedback, where each step encourages the next. It has been suggested, by supporters of century might be needed for a full-blown ice age to take the place of conditions like those we enjoy today.

Cryosphere – The Frozen Earth

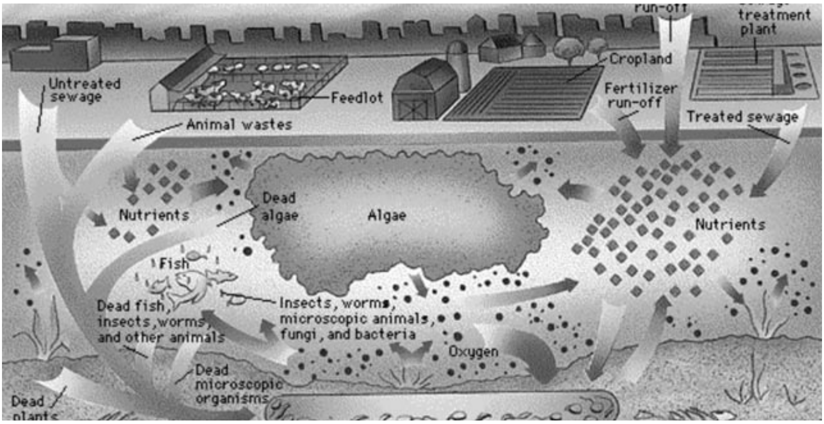
Cryosphere is our frozen Earth. While we tend to focus on the polar ice-caps, the cryosphere includes all the areas of snow, permafrost, glaciers, freshwater and sea ice and forms a huge fraction of the Earth's surface. Glaciers alone account for about 10% and seasonal snow as much as a third of the land surface. Like forest, the cryosphere has a major impact on the albedo of the Earth and therefore the temperature. Furthermore as ice, snow and permafrost, water is much less mobile and therefore does not contribute to e.g. sea level.

Also, it is now known that carbon dioxide and methane are both "locked" in areas of the cryosphere, indeed much of the planets' fresh-water is "locked" within e.g. Antarctica. The cryosphere is an integral part of the global climate system through its influence on surface energy and moisture fluxes, clouds, precipitation, hydrology, and atmospheric and oceanic circulation. Variability in the cryosphere has broad ranging socio-economic impacts, including land and sea transportation, water resources, sea level change, wildlife, and recreation. The cryosphere addresses observations of snow, solid precipitation, lake and river ice, glaciers, ice caps, ice sheets, permafrost, and seasonally frozen ground. Snow and the various forms of ice—the cryosphere—play different roles within the climate system. The two continental ice sheets of Antarctica and Greenland actively influence the global climate over time scales of millennia to millions of years, but may also have more rapid effects on, for example, sea level.

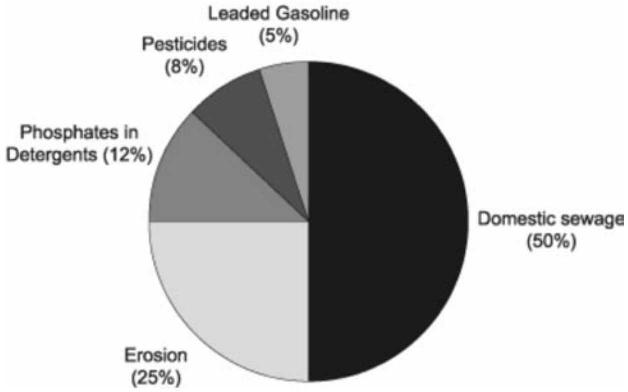
Snow and sea ice, with their large areas but relatively small volumes, are connected to key interactions and feedbacks at global scales, including solar reflectivity and ocean circulation. *Perennially frozen ground or permafrost influences soil water content and vegetation over vast regions and is one of the cryosphere components most sensitive to atmospheric warming trends.* As permafrost warms, organic material stored in permafrost may release greenhouse gases into the atmosphere and increase the rate of global warming. Glaciers and ice caps, as well as river and lake ice, with their smaller areas and volumes react relatively quickly to climate effects, influencing ecosystems and human activities on a local scale and acts as good indicators of climate change. *Scientists generally divide our little blue world into five separate yet overlapping spheres or systems. These spheres are the lithosphere, the atmosphere, the biosphere, cryosphere, and the Hydrosphere. However, Hydrosphere includes Cryosphere, the ice worlds*. Each of these spheres consists of unique properties that separate them from the others. However, as I am sure you have noticed in the picture above, there is no distinct boundary or border between them. The atmosphere extends downward into the soil, into caves and rocks, and even into water. The Hydrosphere and Cryosphere which consists of all the water on Earth extends high into the atmosphere, and deep into the lithosphere, or rocks and soil. The lithosphere often gets carried upward into the atmosphere in the form of dust, and so forth.

Water, Industry and Pollution – The Precariousness of Hydrosphere

Water is an essential resource, without which we could not live. The difficulties of surviving in a dry desert are well known, after all. We must have water to drink and for washing, and without it our crops will not grow. In an industrialized society, however, satisfying such domestic and agricultural needs accounts for only a part of the total amount of water we use. In India, for example, the domestic supply represents about 10 percent of all the water used. Agriculture uses 31 percent, industry 21 percent, and the production of steam for electricity generation 38 percent. In Egypt, where agriculture, mining but not the refining of ores and the financial sector together account for two-thirds of the total value of the gross domestic product, one percent of water is used domestically, 98 percent is taken by agriculture, and industry and power generation take the remaining one percent between them. The contrast is dramatic but its significance is not quite as it may seem, for water is not "used" in the conventional sense. *Even at home, most of the water we drink or use for washing enters the sewers and thus, treated or not, it is returned to the rivers, the sea, or the air to the hydrological cycle.* If industry requires water, then that water has to be supplied, but it is not lost. In the U.S water taken into an industrial plant is used, on average 2.2 times before it is discharged, and a little more than 90 percent of it is returned to the surface water system. Recycling or regeneration is increasingly common practices. These figures are similar to those found in most industrialized countries. After all, it is difficult to remove water altogether from the hydrological cycle.



Liquids are likely to be discharged directly into water. Water is so essential, to the development of industry—generating power. Cooling, or transport, factories congregated along the river banks where the river provided a convenient conduit foe their wastes. By the early years of the last century, the concentrations of industrial effluents had risen to levels high enough to kill all organisms in most of the rivers in the more heavily industrialized regions of the world. Industrial discharges are not the only source of the contaminants which enter the sea. *All over the world, communities living near the coast have found the sea the cheapest and most convenient "sink" into which to pour their sewage, much of it untreated.* Such deliberate release of potentially harmful substances is being brought under control, albeit slowly. Oil is a highly visible contaminant. It floats on the surface of water and when it drifts ashore it coats rocks. Sea birds that dive through it in search of fish also become coated. The oil clogs their feathers, which impairs their insulating qualities, and when the birds try to preen themselves they may swallow lethal amounts of oil. Inshore spills often lead to heavy causalities among sea birds. Seas are fed by rivers and many of the world's largest rivers flow through densely populated and heavily industrialized regions, and contaminants that leak or are discharged into them may be carried to the sea. Agriculture has always been a major source of substances that drain into surface and ground waters, and eventually to the sea.



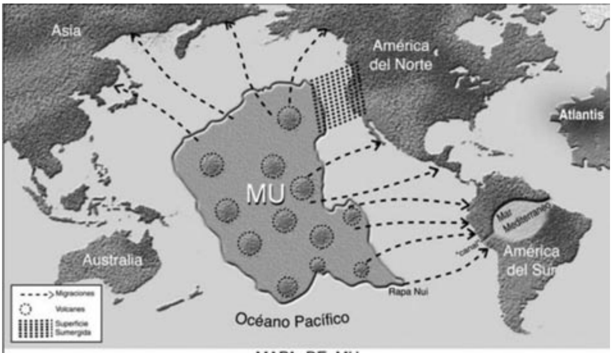
Most of the pesticides in water reach it by this route, although some are washed from the air by rain. Soluble plant nutrients, principally nitrate and a much smaller amount of phosphate are carried by water moving through the soil. Modern farming has increased the rate at which nutrients are leached, partly by ploughing up old grasslands to increase the area sown to arable crops and partly by adding fertilizers. The first ploughing of a soil increases its permeability and allows nutrients to be washed from it more readily. Plant nutrients are not pollutants in the conventional sense, they are not poisonous, but in still or slow-moving waters they can stimulate the growth of aquatic plants to such an extent as to choke waterways. When the plants die and decay, their bacterial decomposition may de-oxygenate the water, causing the death by asphyxiation of many aquatic animals. This type of damage is called "eutrophication."* Some of the discharges are of wastes from manufacturing industry, but not all pollution is the result of discharges. Water can be contaminated by substances that are washed from the air and the mere disturbance of soil and rocks can affect chemical reactions in and around them. *Mining and removal of river sand lower the water table* and exposes the minerals to the air. The water draining from a coal mine may be rich in iron, very acid and, because of chemical reactions between the acid and substances through which it flows—it is likely to collect other metallic compounds, some of which are toxic.

Seven Mega-Disasters of Hydrosphere

1. The Lost Land of Mu or Lemuria – Disaster Number One

Would you believe if I say that I learnt about Lemuria in my middle school—in A. Kattupadi, my village when I was 12 years old, the sister of St.Anne who taught history made it sure that we'll meet Lemurians —on the last Day of Judgment. With such introduction, my quest for Lemurians still continues. Lemuria was an ancient civilization which existed prior to and during the time of Atlantis. Physically, it is believed that Lemuria existed largely in the Southern Pacific, between North

*Eutrophication occurs when large quantities of nutrients such as nitrates and phosphates enter an aquatic environment. Sources of these nutrients include animal wastes, agricultural runoff, and sewage. The ecosystem quickly experiences an increase in photosynthetic and blue-green algae, as these organisms thrive in the presence of the added nutrients. An algae bloom occurs as the algae accumulates into dense, visible patches near the surface of the water, prohibiting light from penetrating deeper areas of lake or stream. Some fish are unable to survive without this light, but for them an even more serious problem arises when the algae begin to die. At this point, oxygen-demanding bacteria take over the ecosystem, decomposing the algae and using up dissolved oxygen in the process. The two major causes of eutrophication are excess nitrates and excess phosphates in water.



MAPA DE MU

America and Asia/Australia. Lemuria is also sometimes referred to as Mu, or the motherland (of Mu). At its peak of civilization, the Lemurian people were both highly evolved and very spiritual. While concrete physical evidence of this ancient continent may be difficult to find many people "know" that they have a strong connection to Lemuria. The notion of a lost continent beneath the Pacific Ocean seems preposterous. But there are many stories and books that reference such a place. Col. James Churchward wrote five books on the lost continent of Mu. There is even a group called "The Lemurian Fellowship" located in Ramona, California, which has published its concept of a map of the lost continent.

Opinions vary as to the outline of the continent. Most agree, that the Pacific region extended north above Hawaii, east past Easter Islands, and to the west at least past Micronesia. Further, the legend says that the area now known as the Hawaiian Islands was the capital district of this land. There is some surprising evidence of an advanced civilization pre-dating the migratory Polynesians. *We know that Polynesians in historical times had only rudimentary ability to shape stone.* They had no known ability to cut stone in the sense that we would cut bread with a knife. Yet we find quite a few stones cut flat, notched, or precisely fitted throughout the Pacific. This raises the questions of who did the work and where they got this extraordinary technology. In Hawaii, you can visit a prehistoric stone wall, called—*"Menehune Ditch."* All that remains is a very small wall beside a road. Most of it is buried under the roadway. Of the small amount that shows, one could admire how nicely the stones are cut and fitted. No known Hawaiians or Pacific Islanders had the technology to do this at that time. So the presence of this construction ability points to an earlier civilization. The earlier people in Hawaii are generally dubbed the Menehune. But the real question is where they originated and where they got this stone cutting technology. It seems that Lemurians were more advanced than the historical Pacific people. The Menehune Ditch exists. The Tonga Arch and Tonga Pyramid*exist.

The amazing ruins of Nan Madol on Pohnpei** exist. All involve cutting, lifting, and fitting stones using unknown technologies. These unknown technologies match or exceed our current abilities.

The proposition about a Lemurian continent and civilization may seem absurd to you at first. The accepted view is that humans arose over millennia from cave dwellers to arrow hunters to pottery makers to farmers to metalworkers and eventually through industrial innovation to us. The Pacific peoples never even developed a metalworking technology. How could there be an earlier civilization of such sophistication without even reaching the metalwork stage? Yet the stones continue to ask these questions of us. How were they cut? How were they lifted? How were they fitted so well? And why was all of this extraordinary construction done? It begins to look as if our assumptions about the Pacific peoples or about the timeline of man are wrong. But if our assumptions are wrong, what other timeline scenario could possibly explain these engineering anomalies?

---

* latest finds, arch and pyramid in Tonga's southern islands show, it was the principal "founding settlement" of Polynesia about 2,800 years ago, and endured long enough for a genetically and culturally distinctive people to evolve and begin spreading across the immense "Polynesian Triangle" bounded by Hawaii in the north, New Zealand in the southwest and fabled Easter Island in the far southeast, not far from the coast of South America.

** No site in Oceania surpasses the dramatic beauty of ancient Nan Madol, perched on the very edge of the vast Pacific Ocean. Situated on the east coast of Pohnpei (also Ponape), the elite administrative and ceremonial center grew, flourished, and declined during the centuries, preceding western contact. Here in a shallow lagoon the ancient Pohnpeians constructed a magnificent complex of ninety-two artificial islets interconnected by a network of waterways. Today the islets are mostly covered by dense jungle growth, and the waterways are largely choked with mangrove swamps. Even in their present state, the megalithic ruins of Nan Madol are present-day reminders of the splendid achievements of prehistoric people in Micronesia.

2. The Lost Civilization of Atlantis – Disaster Number Two

There are many different beliefs as to the actual location of Atlantis. A large percentage believes, as did Plato, that it is a sunken island under the Atlantic Ocean. Others believe it is located near the Greek islands of Crete or Thera (Santorini).

A severe earthquake on 9th July 1956 disturbed the lower strata in a quarry on Thera and the ruins of what appeared to be ancient civilization were found. Human bones, teeth and charred wood, together with pottery and other artistic relics were carbon-14 dated by professor Galanopoulos.

The results pointed to this being the remains of Atlantis. The Azores, Madeira, and the Canary Islands, along with smaller Atlantic islands have also been suggested. Caribbean has also been suggested. In the 1920s, *an American psychic Edgar Cayce predicted that Atlantis would rise again in 1968 from the ocean floor near Bimini in the Bahamas. In fact, in 1968 an airline pilot sighted an emergent temple of great antiquity only a few miles away from the predicted site.*

Since then there have been many more sightings and scuba divers have discovered flights of steps cut into the steep sides of the continental shelf in the same area.

Great circular interrupted patterns of monolithic stones have been photographed on the ocean bottom suggesting a sort of American "Stonehenge." Under water pyramids, vertical walls and even a great arch have also been observed by scuba divers. Dr. Manson Valentine first discovered and explored the "Bimini Road" a sunken wall, foundation or dock, lying at the east of North Bimini.

It is very interesting that these ruins lie within the area known as "The Bermuda Triangle." One suggested explanation is that the Atlanteans possessed laser power through gigantic crystals, as was reported by Edgar Cayce through his psychic readings, several decades before lasers became an accepted part of modern technology. However more recently, South America has become the most favored location. In Peru, enormous stone walls on mountain-tops were a mystery to the conquering Incas and Spanards. An incredible old city Tiahuanaco in Bolivia* was apparently built so long go that prehisoric animals were depicted on the local pottery. Enormous buildings, built at an elevation of 13,500 feet, with walls ten feet thick and foundation stones of 200 tons, were constructed with such exactness and knowledge of physics and astronomy that many investigators are convinced that the builders could not have been of this Earth. All these investigations demand to an entirely new advanced civilizations. Lots of research is conducted on the mystery of Atlantis and thus leaves Atlantis at present, a mega disaster of Hydrosphere.

3. The Dead Sea – Disaster Number Three

Bible has referred Sodom and Gomorrah, twin towns along the coast of Dead Sea that were destroyed by God. "God annihilates "the entire plain" including "the vegetation of the ground" (Gen 19:25). That fatal fertility, so like Eden, is withered in the flames and the Earth that bore it scorched. In its place is left the sterility of the salt of the Dead Sea and of the pillar into which Lot's wife is turned. *Later we come to know these cities as Bab edh-Dhra and Numeira, along the Dead Sea.* The fresh geology of Dead Sea reminds us of that gruesome catastrophe as it had happened just few years ago. For centuries, wealthy Europeans have visited health resorts whose highly mineralized waters they found beneficial. To the east of Europe, the Dead Sea serves a similar purpose. *Indeed, its water is so dense that total immersion presents difficulties because the human body pops to the surface like a cork.* At the same time, of course, it is almost impossible to drown in the Dead Sea, and the relaxations it

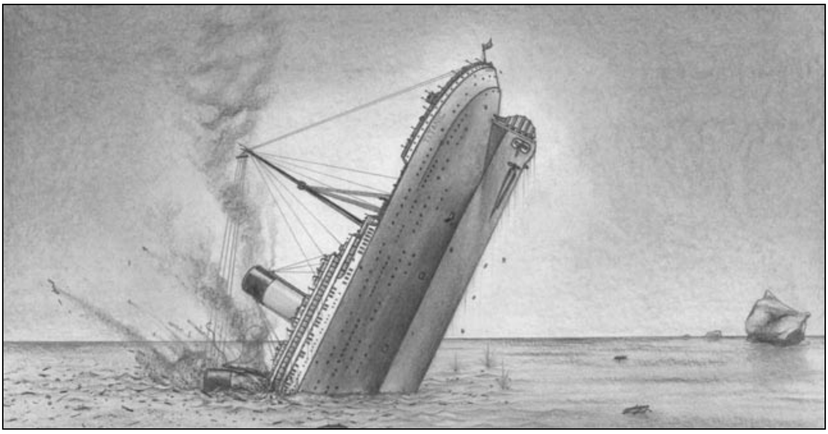
*70 km to the west of La Paz, Bolivia are the mysterious ruins of Tiahuanaco. Little is known about this pre-incan society. The culture of Tiahuanaco was said to have flourished from 500 BC to 900 AD. The stark, austere megaliths are covered with powerful and intricately carved geometric designs. The Kalasaya complex is an enormous platform with a sunken courtyard. Tiahuanaco is located on the southern shores of Lake Titicaca offers include floating easily on your back with no need for an inflatable mattress.

The water contains an average of about 250 parts of salt to every thousand parts of water, with about 195 at the surface and 266 below, compared with about 35 parts per thousand for ocean water. Dead Sea is the saltiest natural water in the world and, at 1302 feet below the level of the Mediterranean it lies at the lowest of the world's seas.

The minerals, with the water itself, are supplied by hundreds of springs and other underground source, by rain, and by the River Jordan. Rainfall is light in this arid region, rarely exceeding 5 inches in a year. The minerals are concentrated in the sea because there is no outflow. Water is lost only by evaporation at an average rate of about 0.4 inches a day. The evaporated water condenses quickly, to form a mist over the surface, and is carried away by the winds. *It is called "Dead" because few organisms can survive in it*. Clearly, there is a great difference between a sea, such as the Dead Sea, and an ocean and the difference is due to the relative isolation of the sea. This does not necessarily mean a sea is true of many seas. The salinity of the Caspian Sea, for example, is about 13 parts per thousand and, in the Gulf of Bothnia, the water of the Baltic contains only about two parts of salt per thousand of water, making it virtually a freshwater sea. These seas are bordered by land, but the Sargasso Sea is not. Its boundaries are formed by the North Atlantic gyre, water bounded by water, yet it is a sea in the true sense because its qualities are easily distinguished from those of the surrounding ocean. In particular, it is more saline than the Atlantic because of the high rate of evaporation, its water containing 36 to 37 parts of salt per thousand of water. Dead Sea is really a mega disaster of Hydrosphere.

4. Titanic – Disaster Number Four

The sea on the evening of Sunday, April 14, 1912, had been unusually calm and the night bitterly cold when the Titanic, the largest and most luxurious ship then afloat, an icon of the Edwardian era rich in pearls and mahogany, socialists and industrialists, plowed into a small mountain of ice. The Titanic was constructed by Harland and Wolf in Belfast, Ireland. The luxury liner had been sailing on its inaugural voyage from Southampton in England to New York City and carried more than 2,200 people, its passenger list a Who's Who of the period. Although a number of prominent American families were aboard the ocean liner, the Titanic was a British ship. The Titanic was described in the popular press as *"practically unsinkable."* This was not unusual for decades, ships had watertight compartments to limit flooding in case of an accident, and the press used this phrase as a matter of routine for many years. Yet the vessel, nearly nine hundred feet long, had been cut open while speeding through icy waters 500km off Newfoundland and had slid beneath the waves in a little more than two and a half hours, taking the lives of more than 1,500 men, women, and children. It was the greatest maritime disaster of the day. The Titanic was 882 feet and 8 inches long and weighed over 46,000 tons. The ship was approximately 11 stories high. The majority of the ship was painted with a glossy black, while the hull trim was painted white. The Titanic departed Southampton, England; made two port calls, one in France and another in Ireland, and was bound for New York City. The first ice warning came in by wireless at 9 am, on the morning of the collision from the Cunard Liner Caronia. As the day progressed, several additional wireless warnings came in from ships in the region warning of ice ahead. After the disaster, Titanic is located under water, 1600 km due east of Boston, Massachusetts and 600 km southeast of St. John's, Newfoundland.



The Titanic's lifeboat capacity was governed by the British Board of Trade's rules, which were drafted in 1894. By 1912, these lifeboat regulations were badly out of date. The Titanic was four times larger than the largest legal classification considered under these rules and by law was not required to carry more than sixteen lifeboats, regardless of the actual number of people onboard. When she left Southampton, the Titanic actually carried more than the law required: sixteen lifeboats and four additional collapsible boats. The shipping industry was aware that the lifeboat regulations were going to be changed soon and Titanic's deck space and davits were designed for the anticipated "boats for all" policy, but until the law actually changed, White Star was not going to install them. The decision seems difficult to understand today, but in 1912, the attitude towards accident prevention was much different. At the turn of the century, ship owners were reluctant to exceed the legal minimum because lifeboats took up most of the space on first and second class decks. Boats were expensive to purchase, maintain, and affected a ship's stability. Finally, in the years before the Titanic Disaster, it was felt that the very presence of large numbers of lifeboats suggested that somehow the vessel was unsafe. Oddly, the same reluctance showed up as late as the 1950s for automobile seatbelts. Car makers at that time were also reluctant to install seatbelts because the belts seemed to imply there was something unsafe about the car. The exact number of survivors tends to vary however the most common reported number is 705. Hundreds died in the freezing waters, none of the half empty lifeboats attempted to rescue anyone from the water. Most of the survivors came from the 1st class passengers with 3rd class, having the worst survival rate. Of the 2,228 people on board the ship; 1,343 of them were passengers and 885 were crew members. There were only enough lifeboats on board the ship to hold 1,178 people. A number of the lifeboats were lowered at less than full capacity, resulting in a significantly smaller survivor number.

There is general agreement that Titanic encountered an iceberg at approximately 11.40 pm (Ship's time) on the night of April 14, 1912 at 41.43.25N latitude, 49.56.55 W. First Officer Murdoch, the officer in charge of the Bridge at that time, reportedly gave the order to stop engines and instructed the Quartermaster to bring the helm, "Hard a'starboard" in a vain attempt to port around the iceberg. The ship actually missed colliding with the above water portion of the iceberg and instead grounded, her keel coming in contact with an underwater ice shelf somewhere along the bottom of the bow section of the vessel, the result of which stripped loose sections of exterior bottom plating in its tank bottom, opening it to the sea. Traveling in excess of 21 knots at the time of impact and having cleared the bow to the left of the above water portion of the berg, Murdoch executed the second half of the "Port Around" maneuver by ordering the helm to Port in an attempt to swing the advancing stem section of the Titanic clear of an impending collision with the visible portion of the iceberg. As the stern began to swing to port, the ship grounded, effectively accelerating the bow's shift to starboard. As the ship's keel rode up on the underwater shelf, a number of things happened in the relatively few seconds of contact. Rivets holding the bottom hull plating in the area of contact were sheared by the movement of those affected plates and large sections of bottom plating in the area of the forward keel of the ship were torn loose and began tumbling to the depths some 4 km below. This contact assisted the ship to change its forward course from easterly to almost north.

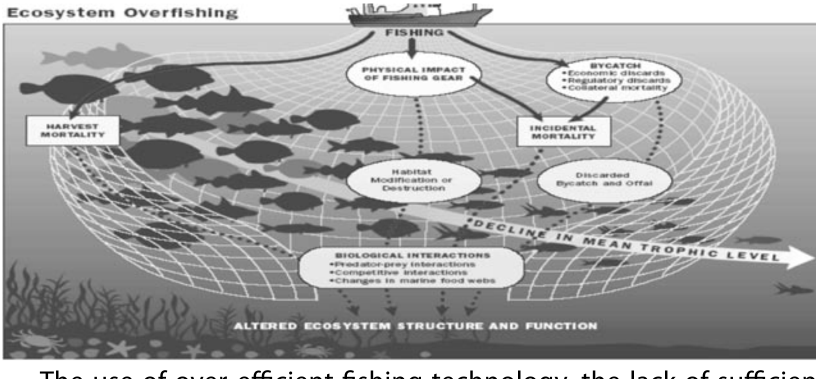
As the Titanic continued to slowly swing north, it also continued to move forward across the underwater shelf before sliding free. During this process, the tremendous weight of the vessel depressed the ice shelf as it rode over it, effectively levering the above water portion of the berg toward the starboard side of the Titanic's forward well deck as it passed, brushing off pieces of surface ice in the process which fell harmlessly to the deck. If such an action had been taken, it would have literally rattled the teeth out of every passenger and crew. Titanic finally came to a stop at approximately 12 midnight, when the order was given to prepare the lifeboats for lowering, and broke up and sank almost two and half hours later at 2.20 am. *The RMS Carpathia is famous as being the Titanic rescue ship, with 705 survivors from the Titanic rescued and the survivors of the Titanic disaster were taken to New York on the Carpathia. 6 years later in 1918, the Carpathia was torpedoed by the U-55, and sank in over 500 feet of water. Chief officer Thomas William Hankinson of RMS Carpathia—the only ship that went to the aid of Titanic—was one of the unsung heroes of the Titanic story. The ship picked up the SOS wireless message from the Titanic, and raced a full speed, though iceberg filled waters, to help in the rescue, although it was the furthest away. The crew of Carpathia could not believe the ship, which they believed to be unsinkable, could possibly have sunk without trace.* The sinking also left a huge dent in the human ego, in the notion of advancement at a time when that idea was at its zenith. Ships back then were society's most advanced technical arts. After the loss of the greatest ship of them all, a true leviathan, the word "progress" never had quite the same ring. Humanity never had quite the same confidence. Four centuries after the start of the scientific revolution, the sinking of the Titanic marked the beginning of a series of technological upsets, of wars and disasters, that shook the twentieth century and drove home the realization that the price of progress is often extraordinarily high. This leaves Titanic a mega disaster of Hydrosphere.

5. Coovam, Chennai, India – Disaster Number Five

Once upon a time, Coovam was a river flowing with sweet fresh water and supporting so much of life in its waters and Tamil literature praises Coovam as haven for biodiversity. Human population have encroached the banks of the river, narrowing it down to a stream. Coovam supposed to be a stream but right now it is drainage or sewage. When it rains the entire plastic and waste clog the stream and water gets into the road in some places, flooding the busy roads and infecting the people using the roads. This stream is used to dump all waste and wastewater and it is a breeding ground for mosquitoes and other disease causing organisms. Monsoon time is the very bad time for the people of Chennai. Coovam can become outrageous during this season. With monsoon we hear the news of outbreak of diseases such as—cholera, viral fever, chikungunya, dengue fever to name a few of them. This is a phenomenon that is recurring in the last few years during the monsoon season. Every year a few hundred people die and thousands of people get sick. Every year we hear the authorities assuring the people that steps will be taken to prevent these diseases. But do they do anything to prevent these diseases? It is true that responsible authorities are not doing sufficient to keep our environment safe. But as citizens are we doing our duty? We, the common man also have some responsibility of dumping these wastes in these streams. All of us have to join together to spread the word about the need to protect the environment from any kind of pollution.

Scientific research shows us that most effluents, including sewage, contain small solid particles that are held in suspension. When the particles settle they may form a dense coating of sludge on plants and on the bed of the waterway. This smothers organisms. The delicate feeding apparatus of invertebrate animals which live on the bed is clogged, and the opaque coating of their leaves inhibits the process of photosynthesis on which plants depend. The sludge contains little or no oxygen and the decomposition of its organic matter, by bacteria that cannot tolerate oxygen, may release gases such as methane and hydrogen sulphide, which are poisonous to many organisms, and which may bubble to the surface, and hydrogen sulphide smells like rotten eggs. The actual effects of pollution are much more complicated and difficult to predict than this simplified outline suggests. The accidental release of a poison, for example, may have a devastating effect immediately, but provided the water is moving and the incident is not repeated life will soon return. Where the pollution is sustained, aquatic plants and animals vary widely in their susceptibility to poisons and oxygen depletion. Life is not destroyed easily and pollution may not even reduce the total mass of living organisms. What happens is that more sensitive species are lost, their places taken by an increase in number among the less sensitive species, and the community as a whole becomes less diverse. A survey of the species present can provide a good indication of the quality of water. Can Coovam be transformed to its earliest glory in history? Of course, but right now it is one of the biggest disasters of Hydrosphere.

6. Over-fishing – Disaster Number Six



The use of over-efficient fishing technology, the lack of sufficient scientific data regarding the oceans, the ignorance and apathy of humanity towards this oceanic crisis, and insufficient implementation of existing maritime agreements are resulting in a decrease in the biodiversity of the ocean, changes to ocean chemistry, changed in the genetic composition of marine species, disturbances to the food web and ecosystem, collapse of fish stocks, and irreparable damage to marine ecosystems and to the fishing industry, including all people dependent on fish for sustenance, income, and cultural value. The problem has not arisen overnight. Historically, fishermen believed that the ocean could support unlimited fishing. As stocks began to collapse, however, international limits and regulations on fishing were implemented. Many nations, however, have cultural and economic ties to the fishing industry that impede the implementation of fishing regulations. Currently, the United Nations is working to control over-fishing, enforce fishing regulations, and resolve international fishing disputes. Examples of the outcomes from over-fishing exist in areas such as the North Sea of Europe, the Grand Banks of North America, East China Sea of Asia, and the Bay of Bengal of India. In these locations, over-fishing has not only proved disastrous to fish stocks but also to the fishing communities relying on the harvest. Like other extractive industries such as forestry and hunting, fishery is susceptible to economic interaction between ownership or stewardship and sustainability, otherwise known as the tragedy of the commons. The FAO scientists publish a two yearly report (SOFIA) on the state of the world's fisheries and aquaculture. The report is generally rather conservative regarding the acknowledging of problems but does show the main issues:

1. 52% of fish stocks are fully exploited
2. 20% are moderately exploited
3. 17% are overexploited
4. 7% are depleted
5. 1% is recovering from depletion

The above chart details that over 25% of all the world's fish stocks, are either overexploited or depleted. Another 52% is fully exploited these are in imminent danger of overexploitation and collapse. Thus a total of almost 80% of the world's fisheries are fully to over-exploited, depleted, or in a state of collapse. Worldwide about 90% of the stocks of large predatory fish stocks are already gone. In the real world all this comes down to two serious problems—we are losing species as well as entire ecosystems. As a result the overall ecological unity of our oceans are under stress and at risk of collapse;

we are in risk of losing a valuable food source many depend upon for social, economical or dietary reasons.

7. The Devil's Triangle – Disaster Number Seven

The Devil's Triangle, also known as The Bermuda Triangle, is most often described as an area extending from Florida to Bermuda, southwest of Puerto Rico and back to Florida through the Bahamas. During the past century more than 50 ships and 20 aircraft sailed into oblivion in the area known as the Devil's Triangle. Some people have claimed that these disappearances fall beyond the boundaries of human error or acts of nature. *Some of these disappearance have been attributed to the paranormal, a suspension of the laws of physics, or activity by extraterrestrial beings by popular culture.* Though a substantial documentation exists showing numerous incidents to have been inaccurately reported or embellished by later authors, and numerous official agencies have gone on record as starting the number and nature of disappearances to be similar to any other area of ocean, many have remained unexplained despite considerable investigation. The area is one of the most heavily-sailed shipping lanes in the world, with ships crossing through it daily for ports in the Americas, Europe, and the Caribbean Islands. Cruise ships are also plentiful, and pleasure craft regularly go back and forth between Florida and the islands. It is also heavily flown route for commercial and private aircraft heading towards the Bahamas and the Florida Straits.

The Gulf Stream Ocean current flows through the Triangle after leaving the Gulf of Mexico; its current of five to six knots may have played a part in a number of disappearances. Sudden storms can and do appear, and in the summer to late fall hurricanes strike the area. The combination of heavy maritime traffic and tempestuous weather makes it inevitable that vessels could founder in storms and be lost without a trace, especially before improved telecommunications, radar, and satellite technology arrived late in the 20th century. According to the Triangle authors, Christopher Columbus was the first person to document something strange in the Triangle, reporting that he and his crew observed *"strange dancing lights on the horizon,"* flames in the sky, and at another point he wrote in his log about bizarre compass bearings in the area. Fate magazine published "Sea Mystery at our Back Door," a short article by George X and in the October 1952 issue covering the loss of several planes and ships, including the loss of Flight 19, a group of five U.S Navy

TBM Avenger bombers on a training mission. The article was titled "The Lost Patrol," by Allen W. Eckert, and his story it was claimed that the flight leader had been heard saying *"We are entering white water, nothing seems right. We don't know where we are, the water is green, no white."* It was also claimed that officials at the Navy board if inquiry stated that the planes "flew off to Mars." "The Lost Patrol" was the first to connect the supernatural to Flight 19, but it would take another author, Vincent Gaddis, writing in the February 1964 Argosy Magazine to take Flight 19 together with other mysterious disappearances and place it under the umbrella of a new catchy name: "The Deadly Bermuda Triangle."

An explanation for some of the disappearance focuses on the presence of vast fields of methane hydrates on the continental shelves. Periodic methane eruptions are capable of producing ship-sized bubbles, or regions of water with so much dissolved gas, that the fluid density is no longer capable of providing adequately buoyancy for ships to float. If this were the case, such an area forming around a ship could cause it to sink almost directly and without warning. Experiments have proven that a methane bubble can indeed sink a ship by decreasing the density of the water. *Methane gas can also crash planes. The less dense air causes planes to lose lift.* Also, the altimeter of planes, the instrument that measures the altitude, functions on the density of air. Because methane is less dense, the altimeter assumes the plane is climbing. Planes at night or in the clouds, where they can't see the ground, assume that they are climbing and dive, causing them to crash. Also, methane in the engine throws off the mix of fuel and air. Aircraft engines burn hydrocarbons (gasoline or jet fuel) with oxygen provided by the air. When the ambient oxygen levels drop, combustion can stop, and the engine stalls. All of these effects of methane gas have been shown experimentally. Laboratory experiments carried out in Australia have proven that bubbles can, indeed, sink a scale model ship by decreasing the density of the water, any wreckage consequently rising to the surface would be rapidly dispersed by the Gulf Stream. It has been hypothesized that periodic methane eruptions (sometimes called "mud volcanoes") may produce regions of frothy water that are no longer capable of providing adequate buoyancy for ships. If this were the case, such an area forming around a ship could cause it to sink very rapidly and without warning.

Hurricanes are extremely powerful storms which are spawned in the Atlantic near the Equator, and have historically been responsible for thousands of lives lost and billions of dollars in damage. The sinking of Francisco de Bobadilla's Spanish fleet in 1502 was the first recorded instance of a destructive hurricane. In 1988, Hurricane Gilbert, one of the most powerful hurricanes in history, set back Jamaica's economy by three years. These storms have in the past caused a number of incidents related to the Triangle. Extremely large waves can appear seemingly at random, even in calm seas. One such rogue wave caused the Ocean Ranger, then the world's largest offshore platform, to capsize in 1982. There is, however, no particular reason to believe rogue waves are more common in the Bermuda region, and this explanation cannot account for the loss of airplanes. Research has shown the freak waves up to 100 feet tall, capable of sinking the largest ships within moments, can and do happen. Although these are very rare, in some areas ocean currents mean they happen more often than the normal. Such waves have now been hypothesized as a cause for many unexplained shipping losses over the years.

Aerial photos taken in year 2005 show the phenomenon of glowing water. Whatever causes this phosphorescence to vent up from the Bahamas Bank bottoms, if that is its cause, remains a mystery. The triangle's location in the Caribbean makes it subject to unpredictable weather patterns. This takes us to Earth changes and the escalation of intense hurricanes in 2005 with more to come in the years ahead. These weather extremes prey on inexperience navigators and smaller boats and planes. Water spouts, sudden electrical and thunder storms, and the like, can cause havoc in the area. The Gulf Stream can also be brutal in that region and perhaps has swept away evidence of natural disasters. Many people have reported seeing portals opening in cloudy skies, strange swirling lights sometimes accompanied by sounds, temporal distortions, electromagnetic distortions called "electronic fog" that can cause a time storm, and the disappearance of planes and ships. There is something about this fog that is important and gives one the sense of all things paranormal. Something unexplained is definitely happening in that region of the Atlantic.

Triangle writers used a number of supernatural theories to explain the events. One explanation pins the blame on leftover technology from the lost continent of Atlantis. Sometimes connected to the Atlantis story is the submerged rock formation known as—the Bimini Road off the island of Bimini in the Bahamas—which is in the Triangle by some definitions. Followers of the purported psychic Edgar Cayce take his prediction that evidence of Atlantis would be found in 1968 or '69 as referring to the discovery of the Bimini Road. Believers describe the formation as a road, wall, or other structure, though geologists consider it to be of natural origin. Other writers attribute the events to UFOs. This idea was used by Steven Spielberg for his film "Close Encounters of the Third Kind," which features the lost Flight 19 as alien abductees. Charles Berlitz, grandson of a distinguished linguist and author of various additional books on anomalous phenomena, has kept in line with this extraordinary explanation, and attributed the losses in the Triangle to anomalous or unexplained forces and leaves it one of the causes of mega disaster of Hydrosphere.

Seven Wonders of Hydrosphere

1. Baptism: The Giver of New Life - First Wonder of Hydrosphere

All religions celebrate the holiness and the newness of water. We see the power of water in the natural world as an agent of creation and purification. Hindus in India believe that the water of Ganges River is holy. Egyptians believed that the Nile was sacred. In Christianity water is used to baptize children. God uses the sacrament of water to give his divine life to those who believe in him. On Easter night water is celebrated, demonstrating the power of water in the history of the world. It's so beautiful that it would be very proper to quote the whole text from the Roman Catholic Missal.

"Father, you give us grace through sacramental signs, which tell us of the wonders of your unseen power. In Baptism we use your gifts of water, which you have made a rich symbol of the grace you give us in this sacrament. At the very dawn of creation your Spirit breathed on the waters, making them the wellspring of all holiness. The waters of the great flood you made a sign of the waters of baptism, that make an end of sin and a new beginning of goodness. Through the waters of the red Sea you led Israel out of slavery, to be an image of God's holy people, set free from sin by baptism. In the waters of the Jordan your son was baptized by John and anointed with the Spirit.

Your son willed that water and blood should flow from his side as he hung upon the cross. After his resurrection he told hi disciples: "Go out and teach all nations, baptizing them in the name of the Father, and of the son, and of the Holy Spirit." Father, look now with love upon your Church, and unseal for her the fountain of baptism. By the power of the Spirit give to the waters of this font the grace of your son. You created humankind in your own likeness: cleanse them from sin in a new birth to innocence by water and the Spirit. We ask you, Father, with your son to send the Holy Spirit upon the water of this font. May all who are buried with Christ in the death of baptism rise also with him to newness of life."

The Christian people, having emerged from the waters of baptism, is sent out to the whole world to bear witness to this salvation, to bring to all people the fruit of Easter, which consists in a new life, freed from sin and restored to its original beauty, to its goodness and truth. Jesus promised to Samaritan woman "ever fresh … gushing water" (John 5:4). Stagnant water brings death and stench, however, fresh gushing water brings abundance of life. With its sacramental importance water is definitely a first wonder of Hydrosphere.

2. Angel Falls, Venezuela – Second Wonder of Hydrosphere

Venezuela is one of the little known gems of South America. Located on the Caribbean Sea and stretching south to the Amazon River rainforest, east to Kaiateur Falls on the border with Guyana and west to the northern Andes, Venezuela has just about everything South America has to offer. Beautiful beaches with coral reef snorkeling. *Angel Falls, the highest water fall in the world, captures everyone's attention.* Angel Falls—spills from the Auyantepui into what is known as the Devil's Canyon 979 meters below. The indigenous people call it Kerepakupai-mer, but it was named Angel Falls after Jimmy Angel, an American bush pilot and gold-hunting adventurer, who discovered it in 1937. The waters fall freely some 2, 648 feet and reach the bottom of the valley as a misty spray that gathers into a small creek which eventually finds its way into the north-bound Churun River. The height of the falls is so great that before getting anywhere near the ground, the water is atomized by the strong winds and turned into mist. The mist can be felt a mile away. The base of the falls feeds into the Kerep River, alternatively known as the Rio Gauya, which flows into the Churun River, a tributary of the Carrao River. It is located in the Canaima National Park a UNESCO World Heritage Site, in the Gran Sabana region of

Bolivar State, Venezuela. No words can describe the beauty of the place indeed it's an angelic vision and a wonder of Hydrosphere.

3. River Nile, Africa – Third Wonder of Hydrosphere

The River Nile is about 6,670 km in length and is the longest river in Africa and in the world. Although it is generally associated with Egypt, only 22% of the Nile's course runs through Egypt. In Egypt, the River Nile creates a fertile green valley across the desert. It was by the banks of the river that one of the oldest civilizations in the world began. It originates in Burundi, south of the Equator, and flows northward through north-eastern Africa, eventually flowing through Egypt and finally draining into the Mediterranean Sea. Lake Victoria, Africa's biggest lake, is generally thought of as the source of the River Nile. On the northern edge of the lake, water pours over a waterfall known as Ripon Falls into a narrow opening which some people believe is the beginning of the River Nile. Ripon Falls may be the starting-point of the river, but the many streams that flow into Lake Victoria could claim to be the true source. Much of Lake Victoria is surrounded by mountains with streams tumbling down into the lake. The largest tributary of Lake Victoria is the Kagera River. *The Kagera and its tributary the Ruvubu, with its headwaters in Burundi, is now considered to be the true source of the Nile. It is from here that the Nile is measured as the world's longest river.* The River Nile is formed from the White Nile, which originates at Lake Victoria and the Blue Nile, which originates at Lake Tana in Ethiopia. These rivers meet in the city of Khartoum, Sudan and then go on their long journey northwards towards the sea. The White Nile is a lot bigger than the Blue Nile, but because of losses along the way, it only contributes about 15% to the flow of the combined Nile. The Blue Nile, rising in Ethiopia, contributes about 85% to the flow of the Nile that passes through Egypt to the Mediterranean.

The ancient Egyptians lived and farmed along the Nile, using the soil to produce food for themselves and their animals. They could not have existed without the Nile. Since rainfall is almost non-existent in Egypt, the floods provided the only source of moisture to sustain crops. Every year, heavy summer rain in the Ethiopian highlands, sent a torrent of water that overflowed the banks of the Nile. When the floods went down, it left thick rich mud black silt which was excellent soil to plant seeds in, after it had been ploughed. The ancient Egyptians could grow crops only in the mud left behind when the Nile flooded. So they all had fields all along the River Nile. Reeds, called papyrus, grew along side of the Nile.

The Egyptians made paper and boats from the reeds. The Nile also gave the ancient Egyptians food. They used spears and nets to catch fish. They would also use the nets to catch birds that flew close to the surface of the water. Another way the Nile helped the ancient Egyptians was in trade. The Nile was the quickest and easiest way to travel from place to place. The name Nile comes from the Greek *"neilos"* which means "valley." The ancient Egyptians called the river *"Ar or Aur"'* which means "black" because of the color of the sediment left after the river's annual flood. To this day Nile continues to sustain life and civilizations, without any hesitation we can call Nile, a wonder of Hydrosphere.

4. Lake Tanganyika, Africa – Fourth Wonder of Hydrosphere

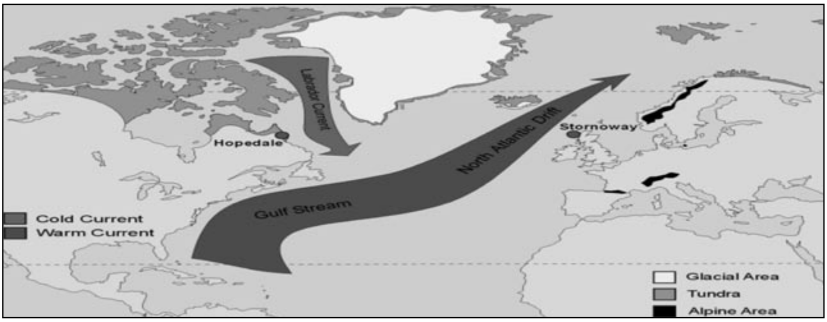
It is situated within the western rift of the geographic feature known as the Great Rift Valley formed by the tectonic East African Rift, and is confined by the mountainous walls of the valley. It is the largest rift lake in the world and the second largest lake by surface area on the continent. It is the deepest lake in Africa and holds the greatest volume of fresh water. It extends for 679 km in a general north-south direction and averages 50 km in width. The lake covers 32,900 cubic km, with a shoreline of 1,828 km and a mean depth of 4,800 feet in the northern basin. The mostly endemic cichlid fauna contains over 200 species. The average surface temperature is between 22-26 degrees Celsius. Lake Tanganyika is like an inland freshwater sea, with most of its fish being endemic to the lake. Animal life usually thought of as being found in our oceans are also represented in the lake, like sponges, crabs, and jellyfish. Lake Tanganyika is a fairly remote lake with some countries experiencing civil unrest in recent years. Most fish that are endemic to the lake command a higher price than fish from Lake Malawi—the other famous rift lake known for "African Cichlids." The water chemistry of Lake Tanganyika is also unique, being very hard and basic (alkaline). While Cichlids from Lake Malawi are primarily mouth brooders, many Tanganyikan Cichlids are substrate spawners, often laying their eggs in caves in the rocks, or in empty snail shells. Tanganyika also has mouth brooders, the most popular being the fish from the genus Tropheus. Shores of Lake Tanganyika houses the world's largest known population of chimpanzees live in the Mahale Mountains that rise behind the lake. Tanganyika provides so much of food and fresh water for drinking and agriculture. Supporting so many species of fish in the lake and so many wild animals around the lake, Lake Tanganyika is one of the wonders of the world.

5. Trenches and Ridges – Fifth Wonder of Hydrosphere

What is a trench? Trench is very deep, elongated cavity bordering a continent or an island arc; it forms when one tectonic plate slides beneath another. *Trench is the deepest part in the ocean.* At least 22 trenches have been identified although not all are classified as major. Of this number, 18 are in the Pacific Ocean, three in the Atlantic Ocean, and one in the Indian Ocean. Where and what is the Mariana Trench? It is a cavity located near the Mariana Islands, where the Pacific Plate and the Philippine Plate converge; *Mariana Trench is the world's deepest trench,* about 36,000 feet. Some other major trenches are: Kermadec-Tonga Trench is a cavity located north of New Zealand, where the Pacific Plate meets the Australian-Indian Plate; it reaches depths of 35,702 feet; Philippine Trench is a cavity bordering the eastern Philippines, reaching depths of 34,578 feet; it results from the Philippine Plate sinking beneath the Eurasian Plate. Kuril Trench is a cavity located northeast of Japan, where the Pacific Plate sliding beneath the Eurasian Plate. Its depth plunges to 34,587 feet. There are other well known trenches, and they are: Puerto Rico Trench which is 27,493 feet; Peru-Chile Trench which is 26,460 feet; Aleutian Trench which is 25,600 feet; Ryukyu Trench which is 24,629 feet; Japan Trench which is 27,929 feet; and Java Trench which is 24,440 feet.

Ridge is underwater mountain range that criss-crosses the oceans and is formed by rising magma in a zone where two plates are moving apart. Mid-Indian Ridge is a mountain range in the middle of the Indian Ocean that separates the African and Australian-Indian Plate; Southwest Indian Ridge is a mountain range, separating the African and Antarctic Plates, it joins the Mid-Indian and Southeast Indian ridges off the coast of Madagascar; Pacific-Antarctic Ridge is a mountain range separating the Pacific and Antarctic Plates, it joins the eastern Pacific Ridge off the coast of South America; East Pacific Ridge is a mountain range that marks the boundary between the Pacific and Cocos Islands Plates to the north, and the Pacific and Nazca Plates to the south; Southeast Indian Ridge is a mountain range separating the Antarctic Plate from the Australian-Indian Plate, its topography is more regular than the topography of the Southwest Indian and Mid-Indian ridge; and the last, but not the least Mid-Atlantic Ridge which is about 7000 miles long, located in the middle of the Atlantic Ocean, some of its mountains reach the surface, forming islands such as Iceland. The Mid-Atlantic Ridge divides the sea floor nearly through the center and stretches from the polar regions of the north to Antarctica in the south. The Mid Atlantic Ridge was created by the splitting apart of the super continent of Pangaea 190 million years ago. The ridge lies about 10,000 feet below water level except in a few areas where it surfaces as islands. This mountain range is as much as 800 km wide. Rugged valleys extend outward from the ridge line to the abyssal plains. This break in the mountain chain allows deep water to flow freely between the Atlantic's east and west sides. The unrestricted movement provides a thorough circulation of the ocean basin that has a pronounced effect on deep water currents, density and temperature and makes it a wonder of Hydrosphere.

The Gulf Stream: Atlantic Ocean – Sixth Wonder of Hydrosphere



Its name gives the impression of a single, coherent movement of water, but the Gulf Stream comprises several currents and its motion is complex. It takes its name from the Gulf of Mexico but, when its north-ward movement reaches the tip of Florida, it becomes the Florida Current 50 to 70 km wide and flowing at 3 to 10 feet per second. At Cape Hatters, North Carolina, the current moves away from the American coast cease to become the Gulf Stream proper, in fact a system of narrow, meandering streams. As the stream approaches Newfoundland, it is deflected by the southward-flowing Labrador Current, bringing cold water from the arctic. It is this confrontation, a little way to the south of the island, between warm and cold water that produces the fogs of Newfoundland, and it is the cold waters of the Labrador Current, washing the shores of New foundland, that produce the cool, damp climate. From the Grand Banks—the current flows eastwards as the warm, shallow—North Atlantic Drift. It divides, part of the drift flowing south again, past the coast of Portugal to complete the gyre by rejoining the North Equatorial Current.

The other section continues east, to wash the shores of north-west Europe and then join the circulation of the arctic waters. The British climate is much milder than it would be were it not influenced by the North Atlantic Drift.

The North Pacific gyre is very similar. The North Equatorial Current is deflected northwards by the Asian coast to become warm, narrow, 80 km wide, fast 10 feet per second, Kuroshio Current, the counterpart of the Gulf Stream. This washes the southern shore of Japan, with the Tsushima current forming a branch that flows into the Sea of Japan, but further north it is deflected by the south-flowing Oyashio Current bringing cold water from the Bering Sea and the Sea of Okhotsk. The climate of Japan, influenced by these two currents, is warm in the south but, in the north, it is cool and, where the warm and cold waters meet, there are fog banks like those of Newfoundland, especially off the coast of Hokkaido. There is a further similarity, in that the meeting of warm and cold, oxygen-rich, waters generates a high level of biological productivity. The Japanese off Hokkaido and the Newfoundlanders on the Grand Banks exploit rich fisheries on which, traditionally, their livelihoods have depended. Gulf Stream provides comfortable climate for life to survive, when climate swings to the extremes. Gulf Stream along with the temperature, also transports nutrients to the fish and sustains life, hence we call it a wonder of Hydrosphere.

Iguazu waterfall, Brazil – Seventh Wonder of Hydrosphere

"In every walk with Nature, one receives far more than he seeks" (John Muir,1877).* Listed one of the wonders of the world Iguazu Falls is rather

*John Muir, American Naturalist, was born in Dunbar, Scotland, in 1838 and died in Los Angeles, California in 1914. Muir's great contribution to wilderness preservation was to successfully promote the idea that wilderness had spiritual as well as economic value.

impressive. Iguazu falls is not just one fall, but is instead a series of 275 different waterfalls on a two and half kilometer stretch of the Iguazu River. A trip along the paths of the Iguazu National Park certainly makes us feel an impressive and powerful demonstration of live nature. The area is also a place to protect some species considered in extinction risk, like yaguarete, ocelot, macuco, and a native flora with more than 2000 species. History and culture are present too, and it's important the presence of original Guarani culture and traditions. Annually, the Park receives about 1 million visitors from all over the world and has been declared "Natural Heritage to the Humanity" by the UNESCO in 1984. Extending for more than 3 kilometers and with a drop of over 200 feet, the sights and sounds of these falls on the Iguazu River should not be missed by anyone cruising to South America. *At any given second, 550 cubic feet of water is gliding off the cliffs that stand about 270 feet high. Words do not do Iguazu Falls justice, one must see for him or herself to understand the magnitude of such natural beauty.* Located on the border of Argentina and Brazil, the two Latin American landmass powerhouses, Iguazu Falls is one of the most unique South American wonders to experience. Cnn.com recently posted Iguazu Falls, in a list of the 14 most romantic destinations on Earth. The 1982 movie "The Mission" was given Oscar trophy for the cinematography, I believe for filming Iguazo Falls, featured in the movie. I agree definitely, calling Iguazu Falls a wonder of Hydrosphere.

Ten Heroes of Hydrosphere

1. Rain – Hero Number One of Hydrosphere

Everybody loves water and on a rainy day you certainly have enough water around. Do you love the sound of rain falling, watching the droplets hit the ground and making a small splash? Have you ever given much thought about rain drops or rain in general? Some do not enjoy when it rains, *but rain is so important to life.* Why not sit back and enjoy the rain for once and even catch it. Honestly, I love rain and want getting soaked from it. I sometimes, celebrate my mass outside in the pouring rain, it is great. When I was a kid I loved to play in the rain, but then I got caught by my mom and you know what happened! I was grounded for a week and that made me to crave more for the rain.

This is how I took my craving to the most extreme, I guess! Sometimes I enjoy rain the most when I am at home watching it from my windows or patio drops fall to the ground. My favorite type of rain is the not so heavy type and when there is just a bit of sun peeking out and knowing a rainbow will come shortly after the rain stops. Usually rain conjures mellow tunes out of me. Perhaps, it's more correct to say I allow the mellow tunes to come out when it's raining.

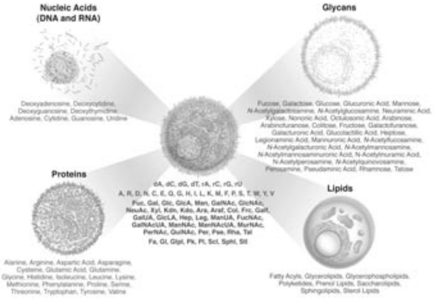
Peacocks can display their feelings of joy, before it rains. Perhaps no one can describe better than Gene Kelley (movie star) when it comes to rain putting apt nostalgic feelings of rain in his song, *"Sing in the rain."* Part of the text goes like this, *"I'm singing in the rain … Just singing in the rain … What a glorious feeling! I'm happy again! I've a smile on my face. I'll walk down the lane, with a happy refrain. 'Cause I'm singing, just singing in the rain."*

I suppose it's not that much of a secret, but it's always felt like one to me. What's the secret? Many times when it rained, I would grab the umbrella, dash out into the ground, and dance and sing in the rain. I knew every word to "Singin' in the Rain" and I would sing at the top of my lungs, spinning and spinning around in circles until I was dizzy. I would find the sidewalk, and jump up and down off of it just like Gene Kelly. I would dip the umbrella and then hold it against my shoulder as I stand to the imaginary policeman.

I still want to go dancing in the rain every time it rains. Do you? It niggles at me, but I feel like I am far too much of an adult to do something foolish like that where everyone could see. May be someday, I'll be brave enough to grab my umbrella and go dancing and singing in the rain. Will you? Recycle the rain to use in gardening and conserve your water usage.

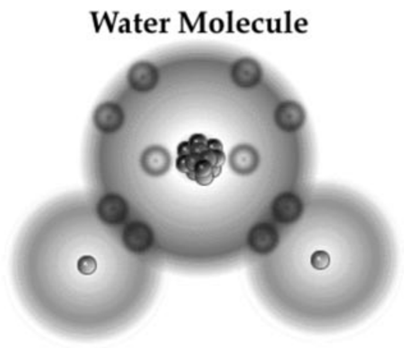
Collect and store gallons of rainwater from your roofs that you can use when it's dry to give thirsty gardens, flowers and trees a drink. Some use it as their complete water supply, but only done safely. Without rain, there is no river, no lake, no ocean, and ultimately no life. Rain definitely a hero of Hydrosphere.

2. The Building Blocks of Life – Hero Number two of Hydrosphere



The cell theory states that all living things are made of cells, which are the basic units of life, and that cells come from other cells. Prokaryotic cells have no nucleus or organelles enclosed within membranes. Species in the domains Archaea and Eubacteria have prokaryotic cells. Eukaryotic cells have a nucleus and organelles that are surrounded by membranes. Each organelle does a specific cell function. All species in the Eukaryota domain (protists, fungi, plants, and animals) have eukaryotic cells individual protists have only one cell, while plants and animals can have trillions of cells. Complex creatures like humans have special cells for special functions like carrying oxygen around the body, digesting food, or making bone. All the building blocks of life use water as a medium to interact. *Recently, a fundamental building block of life has been found in a comet for the first time, bolstering the theory that the raw ingredients of life arrived on Earth from outer space.* Traces of the amino acid glycine were discovered in a sample retrieved by NASA from the tail of comet Wild 2. They were captured 242 million miles from Earth in January 2004 by the Stardust spacecraft. Chains of amino acids are strung together to form protein molecules in everything from hair to the enzymes that regulate chemical reactions inside living organisms. The latest findings add credence to the notion that extraterrestrial objects such as meteorites and comets may have seeded ancient Earth, and other planets, with these raw materials of life that formed elsewhere in the cosmos. The discovery of glycine in a comet supports the idea that the fundamental building blocks of life are prevalent in space, and strengthens the argument that life in the universe may be common rather than rare. Glycine was found in meteorites before, but this is the first time it's been detected in a comet. Glycine is one of the 20 amino acids found in proteins on Earth. Certainly the building block of life is a hero of Hydrosphere.

3. Water Molecule – Hero Number Three of Hydrosphere



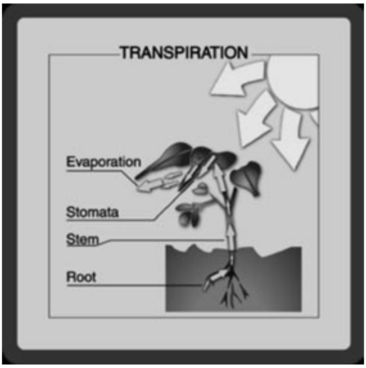
Water is a very important substance, as it makes up the larger part of an organism's body. But what exactly is water? Inside the body of a human being there is a skeleton, which makes your body solid and makes sure you can stand up without falling apart. Water is also a kind of skeleton. It consists of tiny particles, the atoms, just like every other substance of Earth. One of these atoms is called hydrogen and other is called oxygen. As you probably know the air that we breathe also contains oxygen. *One particle of water is called a molecule. When lots of water molecules melt together we can see the water and drink it or use it, for instance to flush a toilet.* A water molecule consists of three atoms; one oxygen and two hydrogen atoms, which are bond together like little magnets.

The atoms consist of matter that has a nucleus in the center. The difference between atoms is expressed by atomic numbers. The atomic number of an atom depends on the number of protons in the nucleus of the atom. Protons are small positively charged particles. Hydrogen has one proton in the nucleus and oxygen has eight. There are also uncharged particles in the nucleus, called neutrons. Next to protons and neutrons, atoms also consist of negatively charged electrons, which can be found in the electron cloud around the nucleus. The number of electrons in an atom equals the number of protons in the nucleus. The attraction between the protons and electrons is what keeps an atom together. The weight of the molecule is determined by the atomic masses of the atoms that it is built of. The atomic mass of an atom is determined by the addition of the number of protons and neutrons in the nucleus, because the electrons hardly weigh anything. When the atomic masses of the separate atoms are known, one simply has to add them up to find the total atomic mass of a molecule, expressed in grams per mol. A mol is an expression of the molair weight of a molecule, derived from the weight of a hydrogen molecule, which is 1 mol. Water Molecule is a hero of Hydrosphere.

4. Transpiration – Hero Number Four of Hydrosphere

In a plant stomata is very small and within it water molecules will adhere strongly to the sides. As water evaporates, the force of adhesion draws more water molecules towards the surface to replace those which have departed. Because the stomata are linked to vessels and, eventually, to the vascular bundles in the xylem, all of which are filled with water, *the force of adhesion constantly draws water upwards.* The mechanism would fail were the column of water, extending from the leaves to the ground, to be broken at any point, but the force of adhesion is complemented by the force of cohesion, by which liquid water molecules are attracted to one another. *This movement of water from the soil, through the plant, and by evaporation into the air, is called "transpiration."* Its rate varies from one plant species to another, according to the temperature and humidity of the air, and it occurs mainly in daytime, when stomata must be opened to permit photosynthesis, but the amount of water involved can be very large. It has been estimated that a banyan tree, with some 250,000 leaves, transpires about 360 liters of water a day.

The phenomenon is seen most dramatically in tropical rain forests, where the rainfall is heavy, the temperature consistently high, and the vegetation very luxuriant. So dense is the foliage that, although it is so intense, the rain drips from leaf to leaf as it travels from the canopy to the forest floor, and from there it is quickly transported back to the leaves, and transpired back into the air. Many scientists fear that widespread clearance of the forests will disrupt this cycle. Instead of being transpired, rainwater will drain into rivers, eroding soils in the process, so reducing the humidity of the atmosphere. The climate will become drier, and this may affect climates far beyond the boundaries of the humid tropics.

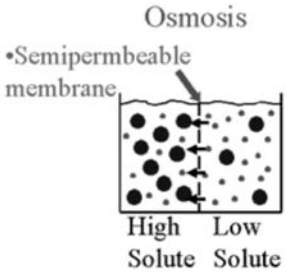


Transpiration by plants also affects the movement of water in the soil. Where the vegetation cover is abundant, rain penetrates the ground and begins to drain horizontally and vertically but, before it travels far, a large amount of it intercepted by plant roots and removed. The amount of rainwater entering the groundwater and draining to river is therefore only a proportion, and perhaps a small proportion, of the total amount that falls. Transpiration by freshwater aquatic plants, on the other hand, can remove so much water as to dry out shallow lakes. Indeed, this is a natural ageing process by which shallow lakes eventually become dry land. If the vegetation cover is removed, the proportion of rainwater draining into the groundwater and rivers increases. On low lying land, perhaps some distance from the area of bare ground, this may lead to rises in the water table that are high enough to cause water-logging of soils, and increase the risk of flooding.

There are ways transpiration can be exploited to advantage. Plants with roots that can tolerate being submerged in water from time to time, and that have a high transpiration rate, are often used to drain wet land. Alder, Eucalyptus, and willow species, which grow naturally along the river banks are often used in this way. Transpiration is a hero.

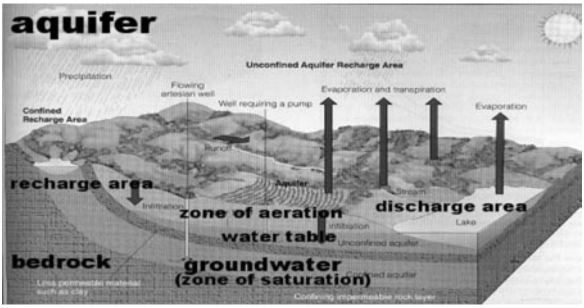
5. Osmosis – Hero Number Five of Hydrosphere

Osmosis is the movement of water through a semipermeable membrane to a higher concentration of solutes. Water easily moves through cell membranes by osmosis. Everyone knows that humans, like all land animals, cannot quench their thirst with salt water. Those who persist in the attempt eventually die from dehydration. If that looks like a paradox, there is another. The physical characteristic that makes salt water poisonous to us is also one that makes life possible at all. If you drink enough salt water, it is possible for your body fluids to become more saline than the fluid inside the cells of your body. Should this happen, water will move by osmosis out of the cells and the cells will dehydrate. *It is clearly vital to the health of cells that the concentration of substances dissolved in body fluids is held constant. The process is called "osmo-regulation," and in mammals it is performed by the kidneys.* Microorganisms that have adapted to live a salty life are better known to scientists as *halophiles*, *which literally mean "salt-lovers."* This is also the fate awaiting the freshwater fish that enters salt water. It will die from dehydration. Should a sea fish enter fresh water the opposite will occur. The fluid inside its cells will be more saline than that outside. Water will enter the cells and continue to do so until the cells rupture.



Most aquatic animals maintain their body fluids at concentrations very close to that of the water in which they live although some, such as eels and salmon, are able to move between fresh water and the sea. The walls of plant cells are reinforced by cellulose, making them much tougher than the membrane surrounding animal cells. The solution inside a plant cell is usually more concentrated than that of the fluid outside it, and so water enters. This fills the cell and makes it swell, but it does not burst as an animal cell would because the cellulose wall is too strong. It is their cellulose walls that give leaves the rigidity they need to expose themselves to sunlight, and that allow non-woody plants to stand erect. When you cut flowers to decorate your home you place them in water in order to "make them last." Eventually, of course, they will wilt, lose their color and their petals, and their stems will become limp. The cells will have died, but the availability of water delays the process. Osmosis is one of the heroes of Hydrosphere.

6. Aquifers – Hero Number Six of Hydrosphere

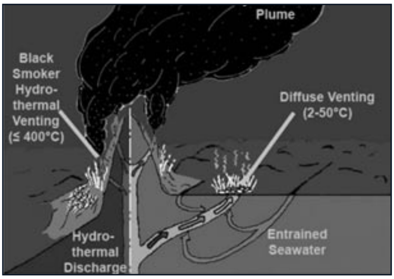


Groundwater results from precipitation that infiltrates the ground and seeps downward through fractures, pores, and other spaces in soil and rock. Because layer of bedrock that lies underneath the Earth's soil cannot be penetrated by water, groundwater usually accumulates above this barrier. The layer of soil directly above bedrock that is completely filled with water is known as the zone of saturation. On top of the zone of saturation lies the water table. During wet weather, the water table becomes soaked with water and rises closer to the surface of the soil, and during dry weather, it falls closer to the zone of saturation. Above the water table lies the zone of aeration, a layer of Earth in which rock and soil may be moist but are not saturated with water.

An aquifer is a porous, water saturated layer of sand, gravel, or bedrock through which groundwater flows. It can be compared to a large, horizontal sponge that absorbs and transports water along its length. A confined aquifer is one that is bounded above and below by beds of rock, while an unconfined aquifer lies underneath a water table. Aquifers continuously receive more water recharge areas, areas of land through which groundwater passes downward into the aquifer. This groundwater moves from the recharge area through the aquifer and out into a discharge area. Examples of discharge areas include lakes, geysers, streams, and oceans. Groundwater usually moves from regions of high altitude and air pressure to regions of low altitude and air pressure. It travels at an extremely slow rate, averaging about only a meter per year. Most of the drinking water in India is obtained from aquifers, as India does not have much of surface fresh water. Without aquifers, life will perish, hence aquifer is a hero.

7. Hydrothermal Vents – Hero Number Seven of Hydrosphere

There may be a place on Earth, albeit somewhat inaccessible, where we might be able to see conditions not unlike those that the earliest life forms saw. The unique conditions around hydrothermal vents make them strong candidates for a deep-ocean location of the origin of life. Volcanic activity beneath the plates releases hot gases and dissolved minerals into the ocean, and heats the water to temperatures of nearly



700 degrees F. at these vent sites subsequently discovered along many other mid-ocean ridges, minerals are spewed into the water in clouds known as "black smokers" that eventually dissolve and disperse into the water column. In the vicinity of these vents, a completely unknown fauna was discovered, living not on oxygen, as every other known life form does, but on hydrogen sulfide, a substance that is poisonous to most living creatures. These chemo-synthetic life forms which include 6 foot-long tubeworms with red, feathery plumes but no mouth and no gut; football-sized, snow-white clams with blood-red innards; ghost-white crabs; yellow mussels; floating "dandelions" that are related to the jellyfishes; and eyeless shrimp with light-detecting organs on their backs.

Discovered in 1985 at the 11,000 foot-deep Trans-Atlantic *Geotraverse (TAG),* the 2 inch-long shrimp *"Rimicaris"* occur in dense schools in the immediate vicinity of hydrothermal vent sites. They have no eyes, but on their dorsal surface there is a pair of organs just below the skin that is light-sensitive. Since they live in total darkness, the ability to "see" is probably unnecessary, but these optical organs may be useful in detecting the faint light emitted by the vents. Like many other hydrothermal vent animals, rift shrimps do not breathe oxygen, but subsist on sulfides dissolved in the water or scraped off the sides of the mineral stacks. In the hydrothermal vents are worms, shrimps, and clams that have adapted to the superheated, sulfurous conditions by becoming functional symbiotic with sulfur bacteria, which provide a source of energy in a low-oxygen environment where sulfide accumulates. *Hydrothermal activity has been one of the suspects of the origin of life.* Scientists believe that the perfect temperatures around the hydrothermal vents could have produced the first molecular form of life, hence hydrothermal vents is a hero.

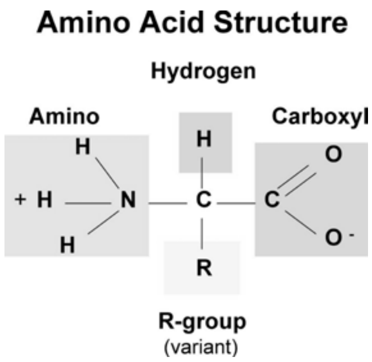
8. Amino Acids – Hero Number Eight of Hydrosphere

This is how life's code could come from such humble beginnings. For a long time, researchers have been fascinated with how complex life was able to evolve in the first place. Lithosphere, through its generous contributions of chemicals, favored the evolution of life. From the primordial soup, a mix of amino-acids and basic RNA molecules, proteins, and eventually more complex structures developed, over millions and billions of years. The genetic code is a triplet code such that every triplet sequence of letters on messenger RNA corresponds to one of the 20 amino acids that make up proteins. *Amino acids are a biochemical building block. They form the building blocks of long chemical chains called protein. Amino acids are also the building blocks of shorter chains called peptides.* There are 20 amino acids that are encoded by the standard genetic code.

Theprimordial amino acids were ammonia, hydrogen, carbon, and methane. Some of the 20 amino acids in the genetic code are essential amino acids, meaning that they cannot be synthesized by the body from the compounds through chemical reactions, but instead must be taken in with food. In humans, the essential amino acids are lysine, leucine, isoleucine, methionine, phenylalanine, threonine, tryptophan, valine, histidine and arginine. Amino acids either would have been brought down to the surface of the young Earth by comets and asteroids from space or would have been created on the Lithosphere by chemical reactions.

Every cell in the body of every living organism, from the humblest bacterium to the giant redwood and the blue whale and including you and me, contains protein. There are many types of proteins, but all of them have large and very complex molecules constructed from arrangements of units, called "amino acids." An amino acid molecule consists of a number of amino groups (NH2) and carboxyl groups (COOH). Some amino acids are made by green plants, using simple inorganic compounds as raw materials. Animals obtain many of those they need by consuming plants, and they are able to synthesize others in their own bodies. All amino acids contain nitrogen (N), and certain of them that are essential for protein synthesis also contain sulfur, so there is some sulfur in all proteins. Sulfur accounts for about one-fifth of the weight of human hair and the feathers of birds, for example. It is also found in many enzymes, and in thiamin (vitamin B1). Phosphorus is also an essential ingredient of some proteins, including the nucleic acids, one of which carries the genetic code. Phosphorus is also involved in the chemical reactions, between adenosine diphosphate (ADP) and adenosine triphosphate (ATP), whereby energy is transported inside organisms and released where it is needed.

Carbon, hydrogen and oxygen are the elements that are used in the largest amounts in all living tissues. These are supplied from the carbon dioxide in the air and from water. Nitrogen is also obtained from the air,



but by a somewhat indirect route. Apart from these four, there are 14 other elements that occur in all living organisms, and 21 that are used by some organisms, but not all. Plants are able to manufacture sugars, proteins, fats and other chemical substances from simple compounds. *Animals cannot construct all these substances for themselves, so they must obtain them by eating plants*. Carnivores obtain the materials they need by eating herbivores. When the plants and animals die, their tissues are consumed by another hierarchy of organisms, and the combined effect is to break down the complex molecules into simpler ones that can be taken up again by plants. The elements essential to life are cycled and recycled endlessly. This makes the process seem straightforward, but there is a problem. Plant roots can absorb nutrient elements only from solutions. This means the nutrients must be in a soluble form, and anything in the soil that is soluble is prone to leaching. A proportion will be carried away in the water, eventually to the sea and, over millions of years the soil might be expected to lose all of its nutrients. The fact that it has not done so, and that plants continue to thrive, indicate the existence of mechanisms whereby nutrients can be cycled on a global scale, through "biogeochemical cycles" that transport elements vast distances by land, sea and air. Indeed, amino acid is a hero.

9. Thermohaline Circulation – Hero Number Nine of Hydrosphere

As the sun shines on the surface of the ocean, water at the ocean surface absorbs its energy and grows warmer. Warm water is very slightly less dense than cold water. The difference is small, but it is sufficient to ensure that the warm surface water floats above the colder water below. There is very little mixing between the warm surface water and the cold deep water. It is only in low latitudes, where the sunshine is most intense, that the surface water is ever warm enough to maintain this separation, however, and in Arctic and Antarctic waters the situation is very different. In these latitudes water at the ocean surface is often warmer than the air above it. The surface water loses heat to the air and becomes cooler, and therefore denser, than the water below. It may grow cold enough for ice crystals to form. *As seawater freezes the salt dissolved in the water is expelled, so the ice crystals that form consist of pure water, although small amount of salt water may be trapped between crystals.* The salt expelled by the freezing process enters the water adjacent to the ice, increasing its density by adding salt molecules to the water molecules without altering the volume of water. This water is, therefore, denser than the water below because it is colder and also because it is saltier. The most abundant salt in seawater is sodium chloride, but the water also contains other chloride salts. The saltiness of water is commonly measured by the amount of chloride it contains, ignoring the metals bonded to the chloride. *This measure is known as the halinity of the water.* The denser water sinks, and less-dense water replaces it at the surface. This process establishes a vertical circulation of ocean water. Because it is driven by differences in temperature and halinity, it is known as the thermohaline circulation. Thermohaline Circulation has a powerful influence on the global climate. It distributes food to different organisms in the oceans and brings comfortable temperatures to organism inhabiting on the land. Indeed, it is a hero.

10. Water Erosion – Hero Number Ten of Hydrosphere

The most influential force in erosion is water. Water's ability to move materials from one location to another, along with the fact that it is found everywhere along the surface of the Earth, make it a superb tool for erosion. Erosion is the detachment of Earth material from the surface. Once detached, agents like water or wind transport the material to a new location where it is deposited. The most ubiquitous form of erosion is that done by water. Do you know that erosion by water is one of the most significant processes shaping the Earth's landforms? Erosion by streams and wave action transforms the Earth's surface, forming incredible natural wonders such as the Grand Canyon and constantly reshaping the world's beaches. However, this dynamic force can also impact our properties. There are different kinds of erosion.

Rain Splash: Rain drop impact causes splash erosion. It is caused by the impact of water striking the surface. Rain splash erosion generally takes place in two steps. As precipitation is absorbed by the surface it fills the pore spaces, loosening soil particles and driving them apart. The impact of subsequent rain drops hitting the surface splash the particle away from the point of impact. The effect is to give the surface a dim-pled-like appearance.

Sheet Erosion: Surface runoff forms when the rainfall intensity of a storm exceeds the infiltration capacity of the soil. Sheet erosion is caused by the unconfined flow of water running across the surface. The effects of sheet erosion are often hard to distinguish because such thin layers of soil are being removed. It isn't until several years later that significant degradation is perceived.

Rill Erosion: It is caused by water concentrating into innumerable, closely-spaced small channels. Left unchecked, rills can cut vertically and horizontally and when joined, for gullies.

Gullies are steep-sided trenches formed by the coalescence of many rills. Once started, they are difficult to stop. Erosion keeps matter into constant move and we call erosion a hero.

Ten Commandments of Hydrosphere

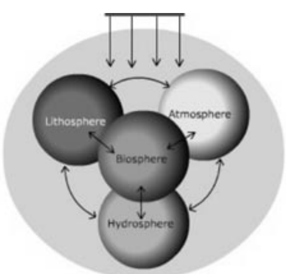
1. Thou shall not put pressure on Hydrosphere by over-consumption of water, limit your use: remember water is life.

2. Thou shall not exploit Hydrosphere by miss management of water, wasting water, and showing no regard for water.

3. Thou shall not dump hazardous and toxic wastes in Hydrosphere, do not litter, do not pollute and remember, other people drink that same water.

4. Thou shall keep the Hydrosphere holy and friendly: learn to respect rivers, lakes, seas and oceans.

5. Thou shall honor Hydrosphere by honoring Earth and its systems, such as Lithosphere, Atmosphere, and Biospher



6. Thou shall not kill or over-fish the seas and the oceans: respect life and remember fishes are your oldest brothers in evolution.

7. Thou shall not abuse rivers, lakes, seas, oceans and their resources: thou shall limit your consumption of fish.

8. Thou shall not use water excessively for washing and bathing: learn to take shorter showers and limit watering your garden.

9. Thou shall save the rain water: make a habit of using the saved rain water for the garden use; remember water is common for all plants, animals and humans.

10. Thou shall not covet the water of the future generations: remember billions species of organisms depend on fresh water.

Finally …

Water and air are the major resources suffering from pollution in many places because they are usually treated as common property, that is, property where no one has exclusivity. The same thing would be rivers and oceans. They have become society's "waste paper basket." We disrespect the very substance that gave life to us. Human story is man's long fascination and dependence on water. From the frozen north to the Sahara desert, from India's Ganges to Ontario's Niagara Falls, water has played a central role in man's development—a giver of life, a transportation route, a transforming medium, a religious vehicle. I believe that water tells us much about God, and his mysteries and his character. There is no doubt that water is a miracle substance that God has placed here as a shadow of himself. If our planet did not have available water, life would have not have been able to occur. When the planet had no water millions of years ago, there was no organic life as we know it. Water is the giver of life, and the sustainer of life. Many of us wonder about the fate of the Earth. Will it be hospitable blue dot forever or will it eventually be consumed by the sun as it swells from medium-sized yellow star to a red giant? As a result, the oceans would boil away and with it, all its life. Atmosphere will be lost to space forever, perhaps our planet would be poisoned, and it would float, cold and desolate through space.