Chapter 10

Microfossils as Saviors?: How to Prepare for Climate Changes… Using Microfossils?

Abstract  Pure & Simple: We study ocean sciences, to understand sea-land processes, communicate alterations caused by global climate (warming & cooling) changes and other environmental problems, collaborate with colleagues globally, and accurately answer questions about challenges we face in the near future, with recommended solutions! With a local presence, global reach and cost effective approach, EcoLogic Project before (ELP) offers the best, most efficient oceanographic, coastal and environmental consulting services in the industry. Our services include vulnerability assessment consultancy, planning, communications, and project management. Also data acquisition, surveys and laboratory analysis. Additionally, we offer educational presentations for the public, private entities, government and municipalities. While adhering to critical project deadlines and milestones, we develop strategies to inform leadership with knowledge and data to effectively pinpoint problematic climate challenges and potential loss. EcoLogicProject unravels the mystery of the effects of Climate Change with Environmental Impact Consultancy and Advisory Services, helping communities prepare, adjust, adapt, and minimize effects or remediate loss. Are you wondering how climate change will affect your family, friends, community, and city? For inquiries, presentations, outlined or detailed Project Assessment and Cost Analysis, please contact us to address your needs for a customized proposal specific to your project. Please send your questions to us at ELP website.

Keywords  EcoLogicProject · Global · Ecological authority · Preservation · Climate change · Predictable indicators · Loss · Remediation · Mitigation · Advisory
Introduction

A global ecological stewardship authority is needed to prepare for Climate Change Affects. The entirety of humanity is failing as it continues toward its own destruction through negligence to integrate gently in cooperation with nature’s balance. We need benevolent leadership that is noble of character placing dignity in moral integrity above profit, to educate, promote, unite and build a shared ambition that inspires unity in all cultures for the conservation and preservation and integrative sustainability needed to thrive within our interdependence of the web of life.

Approximately 70% of the Earth’s surface is covered by oceans, and life likely emerged from there around 3.5 billion years ago. Oceans act as the planet’s thermostat, transferring heat from the tropics to higher latitudes and absorbing a substantial amount of the carbon dioxide that the world’s plant life does not convert into oxygen through photosynthesis.

A comprehensive all-inclusive cooperative global social awareness and stewardship action is needed for the enhancement of biodiversity as a whole. Through enlightened leadership, integrative research, study, and action, we can ensure the protection and pristine restoration of all ecosystems needed to sustain viability for our children, all future generations, and ourselves.

Ignoring the laws of nature—of cooperative sustainable interconnectivity, and replacing this stewardship instead with greed has eroded even the most basic inalienable human and environmental rights. Our collective ignorance and indifference of myopic malaise has led us to the edge of what may well be an irreversible “Anthropocene era 6th extinction”.

The ultimate objective of ‘unite and build’ leadership is not for gaining power and money, but to empower each other to achieve something bigger through collaboration and sharing resources to better preserve nature. Competition for, and depletion of, natural resources, in favor of a few people, does not consider the vital importance of our dependence on all life, and predictably will always lead us to failure. When we are united, we can successfully surmount the challenges of biodiversity loss and climate change, and dramatically alter the current trajectory to extinction. With comprehensive planetary planning that result in effective strategies, we will enable continuity for all living beings, which rely on biodiversity, including humanity, to live with freedom, comfort and dignity, without negatively influencing the earth’s ecosystems or regenerative ability.

Simple logic shows that pollution and extinction are not parallel lines; eventually they will meet, and that timeline appears to be induced, enhanced and accelerated by human activity. And that predictable end is in rapid approach in this Era. The growing body of facts and evidences demonstrate that widespread ecological collapse and biodiversity loss is therefore eminent. As average temperatures rise now, the frequency of extreme events increase, and the impacts of habitat loss and fragmentation will become even more increasingly apparent as well.

We see problems now with food security, as an example the wildlife market in China and the new coronavirus, Covid 19, which besides instability of ecosystem
supply chain poses threats to our old and now outmoded way of life, and of course wildlife and sustainable developments are at risk. It is mandatory that we restore and reconnect our landscapes and watersheds, reduce and eliminate emissions, prevent worldwide species extinctions, sequester carbon, and steward biodiversity to stop the sixth mass extinction event. These problems are accelerating at an unprecedented rate, and kicking off disturbing effects, posing a real threat all life including to human existence.

Humankind is simply one of countless lifeforms that rely heavily on biodiversity and healthy ecosystems to survive and flourish. As species disappear due to habitat destruction, wildlife trade, pollution and climate change, so do the essential parts of a delicate system we depend on for our well-being. When humanity exterminates populations and species of other creatures, it is sawing off the limb on which it is sitting, destroying working parts of our own life-support system. The conservation of endangered species should be elevated to a national and global emergency for governments and institutions, equal to climate disruption to which it is linked (Ehrlich 2015). This refers to extinction of one species impacting other species that rely on it for survival, placing them at a ‘domino effect’ risk of extinction as part of a destructive chain reaction ending on species termination in different trophic levels affecting the ecological chain.

Researchers propose a number of ways in which we can address the problem, including species and regions where preservation and conservation resources can be best directed, highlighting which factors are most impactful in driving these accelerating extinction rates. This research highlights the fragility of the Earth’s support systems and the urgent need to act. The call for the preservation of endangered species to be elevated to a national and global emergency is both warranted and urgent (Clarke 2020).

As we have done with EcoLogicProject.com, our endeavor here is to provide accurate data, with predictable indicators for climate change including but not limited to ocean warming, cooling, and acidification. Our goal at “EcoLogicProject” (ELP) is to add to an enlightened paradigm narrative for humanity’s progress toward sustainable ‘eco-stewardship’. To provide readable reliable accurate information about environmental factors in changing ecosystems, and to demonstrate how global climate change will affect future sea level rise, and environmental, social and economic loss using microfossils.

In addition, we identify patterns and potential problems that may arise now, or in the near future, and we endeavor to make sound recommendations for people to understand and adapt, to make the necessary changes on a warming planet where warmer oceans will expand in addition to water added by melting glaciers and polar areas based on evidences and facts.

The recommendations for change that we offer here range from relocation, and original reforestation and restoration, to collection of debris, and construction of monitoring plans due to climate change effects already worldwide. Shrinking glaciers, and the shifting of latitudinal animal and vegetative cover because of varied tolerance ranges, are evidences of the fact that it is happening in real time, with
predictions now coming to fruition through loss of sea ice, intensified heatwaves and hurricanes, and measurable sea level rise currently around the world.

Temperatures will continue rising for “decades to come” primarily due to human-caused greenhouse gas emissions. Forams are the first consumers and they are the first ones to show if there is a problem locally and globally in the ecological chain, and in the environment as a whole. This is because they show oceanic-source erosional and depositional sites, as well as the deposition of organic matter and other materials coming from land and are statistically accurate and trustable.

The most recent report for the First Order Draft of the IPCC Special Report on Climate Change and Land (SRCCL) published by the Intergovernmental Panel on Climate Change (IPCC), which Professor Eichler is an Expert Reviewer, confirms findings predicting a 1.5 °C increase of temperature above pre-industrial levels around the world. This effect is already bringing more droughts and heat waves, changes in precipitation patterns, stronger more intense and more frequent hurricanes, and an expected sea level rise of between 1 and 4 ft. by the end of this century, all coming from warming and acidification of water and marine sediments evidences. Dr. Eichler recommended, as a part of the IPCC studies from now on, measurement of ocean acidification rate as it poses a problem to all marine life.

Similar past impacts are recorded in marine sediments with evidence unraveled by foraminifera as microfossils, which therefore detect near future local specific problems, giving time for people to understand with evidence to make changes and prepare for what is a “enviro-collapse” bullet-train coming fast in our direction.

Regarding the climate change increase that is coming, we will include in our conversation the 20 Corporations that most pollute the ocean, and that need to be held accountable!

These corporate-influenced changes to the ocean chemistry, currents, and temperatures have profound effects on global weather patterns, and human industrial and consumption activity is adversely impacting the oceans and their complex ecosystems. The result is a number of species that are very sensitive cannot adapt to or tolerate anthropogenic toxic overload inputs, and therefore are becoming extinct.

Pollution from plastic has received much attention in recent years as people cringe at images of tropical beaches covered in garbage. Plastic bags and bottles cause animal deaths, and massive garbage patches are found in all of the world’s largest bodies of water. These debris fields consume all the oxygen in previously healthy areas, generating sites where eutrophication is high and includes the mortality of fishes and other benthic communities. This endangering plastic problem, together with the micro plastics entering the ecological chain has helped raise awareness of ocean pollution; however, this is just one of the problematic issues. Threats to our ocean’s health include greenhouse gas emissions, and especially excessive carbon dioxide, which we are releasing into the atmosphere. These emissions are related to, but not limited to global warming; causing ocean acidification and the consequence is the dissolution of calcareous organisms like foraminifera, crabs, mollusks and many other species that need a CaCO₃ marine environment in equilibrium to be able to form their tests. This dissolution is devastating to specific species and to marine ecosystems in general. In addition to carbon emissions and
plastics pollution, oceans are also polluted and contaminated from oil and chemicals and sewage that wash into rivers and wind up in the oceans. This non-point source pollution includes oil leaked from cars, trucks, and runoff from residential and industrial areas, and farms and ranches that use herbicides, pesticides, and fertilizers flowing into the oceans via rainwater runoff into rivers. When burned, fossil fuels emit greenhouse gases, which also cause ocean acidification, a harmful process that also disrupts marine ecosystems and life on 70% of the planet—"the ocean".

A list of the 20 companies that most pollute the oceans regarding this above-mentioned major sources was compiled by the 24/7 Wall St. It includes major producers of single-use plastic containers, fossil fuel companies, meat and dairy producers, and agricultural chemical manufacturers responsible for the largest share of oceanic contamination, on their relative size in industries that are known to pollute heavily, as well as estimates of these companies greenhouse gas emission effects by third parties.

Here we will talk about them briefly, and why they are polluting. 24/7 Wall St. reviewed information about different sources of pollution: plastic pollution; runoff from agricultural pesticides, herbicides, and fertilizers; and greenhouse gas emissions and discuss some of the issues below. For the primary company sources of plastics pollution, 24/7 Wall St. used a 2018 study of plastic garbage collected in 42 countries and catalogued by Greenpeace and the Break Free from Plastics Movement. For the primary sources of greenhouse gases—oil, gas, and coal companies responsible for the most greenhouse-gas emissions—they reviewed data from 2017s Carbon Majors Database from the Carbon Disclosure Project (CDP), a UK-based charity encouraging carbon emissions reporting. The database considered here is from 2015. Also, a 2018 study from the international nonprofit organization GRAIN and the Institute for Agriculture and Trade Policy (IATP), a non-profit focused on environmental sustainability, provided data on the largest meat and dairy companies that release the most greenhouse gas emissions. They used a 2018 report from Agrow, an agribusiness intelligence company, to find the biggest producers of agricultural chemicals based on sales, which is how they determined the largest polluters in the industry. The U.S. National Oceanic and Atmospheric Administration provided background on so-called non-point source pollution, the ocean pollution that comes from runoff from vehicular oil leaks, farms and ranches and so on.

Saudi Aramco: The state-owned Saudi oil and gas giant is the world’s most profitable company. It is also the biggest emitter of greenhouse gases in the fossil fuel sector. In addition to being the industry leader in GHG emissions from its own operations, Saudi Aramco is the overall leading supplier of fossil fuels in the global energy sector.

Gazprom: The state-owned gas giant and Russia’s most valuable publicly traded company is the second largest source of greenhouse gases, which causes ocean acidification, among global fossil fuel companies based on 2015 data. It ranks third among the top energy companies in terms of greenhouse gas emissions from operations, but the burning of the petroleum liquids and natural gas it produces and sells puts it in second place in overall greenhouse gas emissions, after Saudi Aramco.
National Iranian Oil: ranks second in greenhouse gas emissions from its operations, and third in total emissions linked to its operations and its products, behind Saudi Aramco and Gazprom. Recent U.S. sanctions may have impacted the company’s ranking, but Iran’s state-owned oil and gas company remains one of the top producers and suppliers of greenhouse gases.

Coal India: India’s state-owned coal company is the world’s single largest generator of coal-based pollution, slightly ahead of China’s Shenhua Group, based on 2015 data. It is also the fourth largest producer of greenhouse gases among fossil fuel companies. As the dirtiest source of energy, coal burning contributes heavily to ocean acidification.

Shenhua Group: China’s state-owned largest coal company was slightly behind its Indian counterpart, Coal India, in total greenhouse gas emissions. The company ranks fourth in greenhouse gas production among the world’s top fossil fuel companies, and overall, China’s coal industry is by far the world’s biggest source of greenhouse gas production and supply—responsible for more than 14% of human-sourced greenhouse gas emissions between 1988 and 2015, according to CDP.

Coca-Cola Company: The Atlanta-based beverage behemoth is the top producer of plastic rubbish making its way into the world oceans, wreaking havoc on wildlife and sending plastic particles into the food chain, according to a global sampling last year of trash (Greenpeace and Break Free From Plastic) collected in 42 countries around the world. The world’s leading beverage bottler, which markets hundreds of brands of carbonated beverages, water, and juices, said last year it uses three million tons of plastic packaging annually.

PepsiCo: A global sample of garbage collected on ocean shores and waters last year by Greenpeace and Break Free from Plastic organizations found that the North Carolina-based snack and beverage giant was second to Coca-Cola as the leading source of plastic garbage in the world’s oceans. Plastic packaging can take hundreds of years to decompose, and in the oceans, it breaks down into tiny pieces that enter the food chain and kill wildlife that consumes it.

Nestlé: The Swiss multinational food and beverage company, whose brands include Gerber baby food, Perrier water, and KitKat chocolate among others, is the third largest source of plastic trash found in the oceans, according to a global sample of garbage collected on ocean shores last year by Greenpeace and Break Free From Plastic organizations. The company disclosed this year that it uses 1.7 million tons of plastic annually to produce its plastic packaging.

Danone: The French multinational food and beverage company, whose brands include Activia and Evian, is the fourth largest source of plastic garbage in the world’s oceans. Danone disclosed last year that it uses about 750,000 tons of plastic annually to package its products. Plastic is the most common trash found in the oceans and it wrecks havoc on marine ecosystems.

Mondelez International: A global sample of ocean garbage collected last year found that the Illinois-based confectionary, food, and beverage company is the fifth most common source of plastic marine trash. Unlike other major plastic garbage producers on this list, the maker of Oreo cookies and Cadbury chocolate did not participate in recent U.N. program urging packaging producers to disclose the
amount of plastic they use and to commit to more environmentally friendly practices in the future.

Agrochemical Companies: Bayer, following its 2018 acquisition of Monsanto (a genetically modified seed maker, and the world’s largest genetic pesticide and herbicide (Roundup® etc. sales force) a German multinational pharmaceutical and chemical company became the world’s largest supplier of seeds and agricultural chemicals. These chemicals are a key source of non-point water pollution, tragically with their glyphosate and other pollutants now found in all fresh and ocean waters globally. Like the oil that leaks from vehicles, pesticides like the ones produced by Bayer wind up in rivers that carry agricultural runoff into the oceans.

Syngenta: The Switzerland-based, Chinese-owned agrochemical and seeds producer was the world’s largest by sales in 2017 before Bayer took first position following its acquisition of Monsanto in 2018. As the second largest agrochemical and seeds producer, Syngenta is one of the largest suppliers of herbicides and pesticides used in agricultural activity. These chemicals wash into rivers that carry them into coastal ecosystems.

BASF: The largest chemical company in the world by revenue is also a leading producer of agricultural pesticides, herbicides, and fertilizers. The German multinational company ranked third in agrochemical sales in 2017. Many of these chemicals wind up in the ocean through non-point water pollution, meaning there is no single specific source of contamination.

Corteva: DowDuPont finalized on June 3 the separation of its agricultural business unit into a standalone company, Corteva Agri sciences. The move comes after the completion of a merger between Michigan-based The Dow Chemical Company and Delaware’s E.I. du Pont de Nemours in 2017. The merger made DowDuPont the fourth largest seller of agrochemicals, the segment now under the Corteva name. Herbicides, pesticides, and fertilizers pollute ocean water from rainwater runoff that makes its way to rivers, tributaries, and coastal wetlands.

ADAMA: The Israel-based, Chinese-owned company is a leading producer of agricultural chemicals and the world’s largest producer of generic pesticides. It was acquired by China National Chemical Group in 2011. ChemChina later bought Syngenta, putting two major agrochemical producers under one parent company. Herbicides, pesticides, and fertilizers pollute oceans through rainwater runoff into rivers.

Meat and Dairy Corporations: JBS, the Brazilian multinational company is both the world’s largest meat processor and the biggest single emitter of greenhouse gases in the global food industry, according to the Institute for Agriculture and Trade Policy and the international nonprofit GRAIN. The seller of meat, chicken, and pork products is responsible for more GHG emissions than the other top three leading meat and dairy companies combined. Carbon dioxide, the primary greenhouse gas, makes ocean water more acidic, which then causes great harm to marine ecosystems.

Tyson Foods: Arkansas-based Tyson is the second largest meat processor and the second biggest emitter of greenhouse gases in the global food industry, making it, according to the Institute for Agriculture and Trade Policy, one of the largest single
sources of greenhouse gas emissions on the planet, when the energy used to produce animal feed and the agricultural chemicals used to grow it are considered. The primary greenhouse gas, carbon dioxide, makes seawater more acidic and harmful to ecosystems.

Cargill: The Minnesota-based, privately held conglomerate is heavily involved in the production of livestock and grains for livestock nutrition. Cargill’s operations are not limited to meat and poultry as the company’s diverse businesses include agriculture products, food and beverages, beauty products and more. The company ranks as the third biggest source of greenhouse gas emissions in the global livestock industry, according to a report last year by the Institute for Agriculture and Trade Policy and the international nonprofit GRAIN.

Dairy Farmers of America: The Kansas-based milk marketing cooperative is the fourth biggest source of greenhouse gas emissions in the meat and dairy industry if its livestock feed and agrochemicals operations are included. Much of the carbon dioxide from meat and dairy production winds up in the oceans, which makes them more acidic and harmful to sea life.

Fonterra: New Zealand commands an enormous share of the market in global whole milk powder, and much of that is under the control of Fonterra. The company is the fifth largest source of GHG emissions when the energy used to produce feedstock is included.

Our daily choices should include the best options such as sustainable small farms which work side by side with the nature and focus on local products and services.

Children Are the Future of the World. We Should Prepare Them to Choose Well

How can we prepare our children for their future on a warming planet?

We must also consider their children, grandchildren and so on… This is looking far ahead, but that is what is needed now. Looking far ahead to the future will likely prevent ecologic collapse as well as acute and chronic economic, and even emotional loss.

We think it’s better to enlighten children, students, and society, with the knowledge, perspicacious wisdom, ability, tools and skills needed now rather than to wait until humanity is forced to adapt, or runs out of time when it’s too late. Apart from educating ourselves to consume less “stuff” in general, avoid meat and dairy, and to buy used or repurposed items, we know that learning to garden, self-reliance and self-sufficiency and so on is, in effect, “printing money”. These assets will allow others to survive food shortages and social and economic collapse, and produce available resources to consume for themselves. Serious and widespread collapses are likely to occur during your lifetime, and your children’s lifetimes.

Consequences of climate change include a die-off of most of the world’s coral reefs, of biodiverse wet forests, risks to economic growth, and starvation-level food
shortages, particularly in not yet developed countries. If a rapid reduction in heat-trapping gases does not occur soon enough, the world is likely to cross the 1.5 °C threshold roughly around 2040, when many of our youngest children will be in their 30s.

**How to Prepare Children for a Warming and Acidic New World?**

Kids should be engaged in small conversations, which help them feel empowered rather than frightened, about the heating of our planet. As both a moral and a practical matter, they need to know that ocean warming and acidification is happening due to climate change, and that unfortunately it is likely to affect them and their children. To prepare children by talking with them, we suggest the need to start by studying available data, as well as oneself—self-reflection. For both children and adults, NASA's excellent climate website is very useful. Age-appropriate books and programs are important, and to hear about it from other children as well as adults. If we are able to educate our children about climate change, we will help them to make wise choices now and when they are adults. They will know, for one example, the risks of buying ocean-front property.

Please see Fig. 10.1 on some examples of houses constructed on top of dune vegetation. Sand dune vegetation protects land from ocean intrusion. If dune vegetation is removed, the roots that retain sediment responsible for the fixation and stability of the sand are also removed. If the original vegetation is replaced by concrete, the results are not pretty, and construction will likely collapse and fail.

Here we also show an example on Campeche beach, Florianópolis, Brazil, in 2020, of exactly what is not supposed to be happening at the beach. Bringing wood,

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**Fig. 10.1** House constructed on top of dune vegetation. The dune vegetation is the protection of the land from ocean intrusion. Removal of dune vegetation, removes roots that retain sediment, responsible for the stability of the sand. If the original vegetation is replaced by concrete, the result is failure and pollution (and an ugly beachfront!)
steel and concrete, with plastic sandbags and not taking away the debris are not
good solutions, because the ocean will likely to keep invading the now unstable
sand-dune-foundation.

The illegal construction example pictured here, will surely end up in the ocean
with toxic materials disrupting the entire ecological chain. Private owners want to
stop the ocean and they had the approval of the local civil defense and the permit
inspection agency!! The public power agency disapproved this construction, how-
ever with few personnel or necessary equipment, they do not come to inspect, stop
or even to fine these infractions.

Our children need to have practical skills, which will be useful if disasters inter-
rupt the normal flow of goods and services. Brief interruptions require knowing how
to prepare for and survive a few days on your own, with flashlights, canned foods,
and other emergency supplies. If longer interruptions occur, we all need to know
how to garden, preserve food, safely gather and filter water, make repairs to a dam-
aged home, sew clothing, provide medical care, install or fix solar arrays, use
self-defense techniques, and so on. Children’s interests should also guide the skills
they learn. They can learn how to gather edibles, fish, and plant and preserve
produce.

We should also prioritize our abilities to prepare for the projected climate impacts
in each region; heat waves, poor air quality, sea level rise, and intense rainfall in the
future, for example. We should learn and teach how to prevent heat stroke if one
lives in a heat-wave area, including cities. It is important to explain how to stay safe
in flash-flooding conditions, since intense precipitation is becoming more common.
And unfortunately, because we all can expect worsening air quality, we should show
them how to monitor outdoor air conditions.

Resilience in a climate crisis also emphasizes the importance of strengthening
social networks within communities by encouraging them to create patterns of
working together to overcome adversity, whether physical or psychological. We
need to teach our children how to collaborate with and play well with others, while
visualizing the best they can do for themselves and for others. This will help prepare
them for difficult and harsh times, whether they arise from climate change or other
natural or anthropic causes.

To engage in the citizenship of life, to the extent that we are able, to vote, write
letters to ‘the editor’, contacting politicians or political leaders, and participate in
community groups that are organizing others to do a project that will benefit the
community. Our example becomes the model that our children need to build stron-
ger communities. Also talking to them about how to work with others to overcome
general or specific problems.

Policymakers at the U.S. Environmental Protection Agency (EPA) published a
report in the Federal Register outlining how local communities should start plan-
ning for near-future catastrophes associated with climate change; and it is a must-
read if for yourself and for others to be prepared!
How to Plan for Natural Disaster Debris?

We need to go beyond resilience to anticipate, plan, and prepare for impacts of climate change. In particular, it addresses ‘how local communities can cope with debris and disaster following floods, hurricanes, or wildfires intensified by a changing climate, because it is expected to increase the frequency and intensity of some natural disasters’, reads the report citing a 2014 National Climate Assessment. “The amount of debris generated by natural disasters, and the costs to manage it, will likely increase as a result”, and “most threats from climate change are at 50 to 75 years out”.

These threats represent an important change we have to address! Climate change is not some problem in the distant future. It is happening right now in every part of the world. When people say the increase size and scope of wildfires, hurricanes, and heat waves they are experiencing are unlike anything they have ever seen before, there is a reason for that. That reason is climate change. Also, the local pollution is another acute problem which decrease biodiversity as a whole (Fig. 10.2).

It is no secret that the world is seeing the consequences of climate change. Our shrinking glaciers, latitudinal shifting plant, and animal ranges are evidence that it is happening in real time, with past predictions now coming to fruition through loss of sea ice, intensified heatwaves, and sea level rise around the world.

Our EcoLogicProject (ELP) is confident that temperatures will continue rising for “decades to come”, primarily due to human-caused greenhouse gas emissions. So, when it comes to planning, communities should assume “the worst-case scenario” as they adapt to the “debris-related impacts of climate change.”

Across all nations, flooding is expected to intensify even in areas where total precipitation is projected to decline. Climate change is expected to increase the frequency and intensity of some natural disasters because we are going to a Pliocene like climate, the warmest periods of the earth.

Larger amounts of debris will affect wider areas, contributing to a greater risk of chemical and industrial release from facilities, and increased gas emissions from debris management activities, among other things.

![Fig. 10.2](image1.png) Fauna inhabiting debris areas in the aquatic world
ELP has a mission to pinpoint the problems, include key stakeholders to identify potential debris streams due to sea level rise in coastal zones, evaluate potential sites of debris deposition and areas where they are exported in the marine world. Also to identify recycling programs to see if they can be scaled up during disasters, and address health and safety considerations specifically as it relates to future planning to mitigate and remediate the effects of climate change.

So why use microfossils, and why study paleoclimate? What can past climate teach us about the future? We know by now that rising greenhouse gas concentrations are driving profound changes to the earth, including warming, sea level rise, increases in climate and weather extremes, ocean acidification, and ecological shifts.

Past climate variability, over the last centuries-to millennia, serves as the most relevant baseline against which to measure anthropogenic changes in climate. Farther back in time, larger reorganizations of the earth system provide critical information about the rates and magnitudes of physical, chemical, and ecological changes under a suite of different greenhouse gas concentrations.

The vast majority of instrumental observations of climate begin during the late twentieth century, during a period of rapid anthropogenic warming, and as such reflect the altered physics and chemistry of the anthropogenic era. The so-called paleoclimate records of past environmental changes capture a rich spectrum of Earth’s history that climate scientists use to inform future climate changes in a variety of ways. Given that it will take many millennia for the earth system to come into equilibrium with present-day atmospheric greenhouse gas concentrations, past climate conditions help scientists understand the true sensitivity of the earth system to both small and large changes in climate conditions.

At their most basic level, records of past climate change serve as a critical backdrop for current anthropogenic climate trends, in many cases allowing for the separation of natural variability and greenhouse-induced trends in earth’s climate. In recent millennia, atmospheric CO$_2$ concentrations were relatively stable, such that changes in solar irradiance and volcanic eruptions represented the primary drivers of global climate variability. During this time, global temperature varied by less than 0.5 °C and sea level varied by no more than 10 cm.

Exceptionally high-resolution records spanning the last several centuries allow for the quantification of past climate extremes such as severe drought, ENSO (el Nino southern Oscillation) events, wildfires, and tropical storms.

Indeed, the last millennia provides a wealth of data that climate scientists use to probe the relationship between the global climate state and the character of climate extremes. As such, it offers a rich testbed for climate models that are used to project twenty-first century climate changes, which must account for natural as well as solar, volcanic, and greenhouse-forced climate variability. Rising greenhouse gas concentrations reflect large-scale changes in the Earth’s carbon cycle, such that, studies of past changes in carbon fluxes and associated climate changes are highly relevant to projections of future anthropogenic climate change.

Over the last million years, Earth has transitioned from glacial climate states characterized by markedly lower atmospheric CO$_2$ concentrations (200 parts per million) to interglacial climate states (280–300 parts per million) every
~100,000 years. Profound shifts in polar ice sheet mass, sea ice extent, sea level, ocean circulation, global temperature, precipitation patterns, and climate extremes accompanied these glacial-interglacial shifts.

Abundant evidence of abrupt climate change during the last glacial period illustrate the potential for rapid climate responses to much slower changes in climate forcing – a high-risk but highly uncertain scenario for twenty-first century climate changes.

Much further back in geologic time, deep-sea sediments record a climate state when changes in the Earth’s carbon cycle caused atmospheric CO₂ concentrations to climb to ~1000 ppm—similar to levels expected in coming decades if emissions continue unabated. During this time, roughly 50 million years ago, global temperatures were as much as 8 °C warmer, sea level was more than 20 m higher, and ocean pH varied appreciably. While the rates of present-day atmospheric CO₂ change, temperature change, ocean pH change, and sea level rise are much higher than they were during past geologic intervals, these “hothouse” worlds hold key lessons for our climate future. This is especially true as models that were constructed and tested against instrumental climate data are charged with projecting climate changes that occur under vastly different conditions than today.

With our EcoLogicProject Climate Science Consultancy & Academic Advisory Service, we show ways to preserve and conserve the environment through global warming and climate change research, including effects of sea-level rise, and how to help communities to prepare now, for the near future.

ELP assesses and monitors the paleoenvironmental-change-record and its current-timeline implications. Collected data indicates carbon-overload, and acidification causing ocean warming, contributing to sea-level rise. This allows us to provide an accurate prediction of future impact effects.

Globally near-shore to deep ocean and in tropical to polar climates we research Forams microorganisms and their distribution in the sediment. Foraminifera are an accurate, inexpensive and easily handled proxy to identify at-risk environmental conditions, including areas experiencing hazardous pollution or contamination.

ELP offers unique access to a dedicated team of professionals who specialize in a variety of interrelated expertise. Our combined abilities solve multifaceted environmental challenges in an efficient, timely, and cost-effective manner.

ELP’s cofounders comprise our core team. ELP’s Science Division also collaborates with a diverse group of highly skilled environmental science colleagues and professionals with expertise in the the following fields: Marine biology, Marine geology & geophysics, Physical oceanography, Biological oceanography, Fish ecology, Environmental impacts, Endangered, exotic and invasive species, Marine mammals, birds, and turtles, Biostatistics, Marine habitat restoration, GIS, Coastal zone management, Underwater photography, Remote sensing data interpretation.

Our mission is committed to offering the best and most efficient oceanographic, coastal and environmental consulting services in the industry. Offering cost-effective solutions, we navigate among interrelated disciplines including physical oceanography, hydrology, marine biology, coastal & marine geology and climate science.
Achieving accurate research results, we also manage, coordinate, and facilitate ocean research and education programs. ELP shares ocean exploration and observing, analysis, and prediction information through mentoring, advocacy, program management, and facilitation across a wide spectrum of communities. These include oceanographic and academia, formal and informal education, technological and industrial institutions, government entities and municipalities, and the public. Our logos represent what we fight for.