# Traditional Foods and Medicines and Mounting Chronic Disease for Indigenous Peoples Worldwide

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## ABSTRACT

This essay discusses the rationale, theoretical foundation, method and focus of the two-year study: **"Indigenous Peoples' Health: Effects of Elevated Atmospheric CO2 on Plant and Animal-based Foods and Medicines"** undertaken by the Center for World Indigenous Studies beginning in late 2017. The study employs a relational investigative approach aimed at establishing the effects of elevated atmospheric CO2 on traditional plants and animals on which indigenous peoples rely for their daily diet. There are many factors such as "nutritional transition" where Fourth World (indigenous) peoples have become reliant on commercially produced foods and medicines, industrial development intervening through mineral extraction, oil extraction and construction of towns which have all contributed to adverse health effects among Fourth World peoples. Researchers (conventional and indigenous) have identified evidence that elevated CO2 in the atmosphere may contribute to a significant decline in micro-nutrient and macro-nutrient values in plants and animals and increase sugars—potentially contributing to increased incidents of chronic disease. While increased CO2 levels (and other greenhouse gases) in the earth's atmosphere contribute to Global Warming—regularly referred to as "climate change"—the great concern in public research and public discourse is that the radically varying weather patterns contribute to destruction and growing risks of damage to human infrastructure and other economically important activities throughout the world. The "health factor" is usually associated with increased temperatures directly affecting human health, but the food base that is reliant on photosynthesis to produce the nutrients and medicines on which human beings rely tends to be ignored. In this article the author discusses the multivariate factors limiting orthodox researchers examining plant-based and animal-based food, medicines used by Fourth World communities that prevent a full understanding of growing levels of chronic disease among Fourth World peoples. This analysis may provide valuable information for future research and for reporting to indigenous health leaders as well as orthodox health providers concerning the use of plant-based and animal-based for food, medicines, and pharmacological support.

***Key Words:*** Fourth World peoples, climate change, atmospheric CO2 levels, wild foods, plant-based, animal-based, traditional medicine, ethno-botany, indigenous health, food policy

Fourth World nations around the world live under conditions of frequent, if not constant, threat to their cultural, social, economic and political continuity as culturally distinct peoples. The threats come in the form of military violence committed by state authorities and notably development carried out by industrial societies through their constant expansion into biodiverse regions of the world to gain control over the use of petroleum, conduct of nuclear tests, establishment of cities, extraction of minerals and coal, clearing of forests to set up industrial farming and taking of timber for pulp and precious wood, and commercial taking of plants and animals for foods and pharmaceuticals. The consequence of these activities conducted in the name of "growth to increase stock payouts and stock margins" is the production of enormous quantities of nuclear, commercial, medical, and human waste, plastics, elevated levels of CO2 and other gases in the earth's atmosphere driving global temperature ever higher. The combination of constant "development expansion" and waste not only spoils earth's environment threatening the life of every living being on the planet, but indigenous nations are the first to receive the adverse effects. Indigenous nations, like the proverbial canary in the coal mine (I had to use this industrial metaphor), suffer from the adverse effects of constant development pressing into their territories and breaking down the biodiverse environments in which they live. They are the first in the world to die or become chronically ill due to the uncontrolled industrial disaster ravaging the Fourth World largely unnoticed by industrial peoples.

While I recognize the extensive damage to indigenous nations by industrial development and waste production, indigenous peoples' reliance on plants and animals for foods and medicines from biodiverse environments appears to be seriously endangered by elevated levels of CO2 in the earth's atmosphere. The Center for World Indigenous Studies (CWIS) is conducting a multi-year study to assess the actual and potential adverse effects on plant-based and animal-based foods and medicines and the potentially changing nutritional and medicinal values of those foods and medicines on which indigenous peoples rely. This essay discusses factors, theories and methods applied in the CWIS study entitled, **"Indigenous Peoples' Health: Effects of Elevated Atmospheric CO2 on Plant and Animal-based Foods and Medicines."**

Incidents of chronic disease in countries worldwide (e.g., diabetes, heart disease, kidney disease, cancers, anemia, wasting, iron deficiencies, low birth weight) have increased at a steady pace since the beginning of the twentieth century. Rates more rapidly increase for Fourth World indigenous peoples living in rural and biologically diverse areas while lower rates of increase are occurring for non-indigenous peoples living in urbanized settings. One third of the deaths due to diet and physical

activity related chronic disease between 1960 and 2007[1] or 16.6% of all deaths were recorded by the Center for Disease Control for the United States populations. While for the general population of countries such as India, Brazil, Mexico, China, Australia, and Canada, there is a slow rise (possibly associated with population increase as a factor) in incidents of chronic disease, state health institutions generally report that, in urban and suburban areas, through various prevention and treatment methods, the increases in heart disease, Type 2 Diabetes and obesity increases have slowed. This is in contrast to academic and health agency reports that chronic diseases (Type 2 Diabetes, Chronic Kidney Disease, Heart disease, etc.) among indigenous peoples continue to increase unabated in countries as diverse as Australia, Nigeria, India, Brazil, Canada, and China ("Chronic disease in China" 2018; Garcia-Garcia et al., 2015; Harris et al., 2017).

Clearly there are factors associated with the changes in chronic health results for indigenous peoples that are not fully reported or understood. Indeed, researchers in the state institutions frequently report that they lack access to indigenous communities and cannot document evidence associated with indigenous communities unless people from these communities use facilities sponsored by universities and state agencies for treatment. And the primary emphasis of these agencies generally has been chronic disease management instead of prevention. Most researchers approach chronic health research as a "top-down" proposition or from a deeply "reductive" perspective. When examining causes and preventions of chronic disease for indigenous peoples there are, as some researchers report, serious obstacles including lack of access to populations, narrowly focused research on only individuals who have access to health clinics or hospitals, and significantly the general fact that data that may exist in institutional records have not be disaggregated to separate out indigenous peoples as a specific cohort. The consequence of these obstacles is that virtually all published research and even data provided by indigenous health centers tend to be skewed to only cohorts served in clinics and hospitals with variable definitions of "indigenous" recorded in databases.

With the obvious shortcomings of state generated chronic health data some researchers report the incidence of chronic disease among Fourth World (indigenous) peoples around the world as trending significantly upward (Harris et al., 2017)—exceeding the incidence of chronic diseases in the non-indigenous populations. Indigenous peoples in virtually every country where they are located experience many preventable diseases such as Type 2 Diabetes, obesity, wasting, cancers, heart disease, arthritis, chronic kidney disease and allergies. Yet, despite even superficial evidence of rapidly increasing levels of chronic diseases among the many different indigenous peoples around the world, very limited research or analysis of the problem focuses on their causes and prevention. When causes are mentioned, alcohol consumption, tobacco use and lack of physical activity are commonly referenced and treatment is focused on managing the disease.

## Epidemiological Transitions over Time

Epidemiological transitions have typically fol-

[1] Mokdad, A.H., Marks, J.S., Stroup, D.E., Gerberding, J.L.(2004). Actual cases of death in the United States, 2000. JAMA,291:1238—45.

lowed a pattern in human history. To better understand the advancement of health changes in populations in relation to death rates researchers postulate stages of epidemiological transition beginning with the Age of Pestilence and Famine (roughly dated as before the Neolithic Age 7000 BCE – 9000 BCE to about 1,750 AD), followed by the Age of Receding Pandemics (about 1750 – 1920), and the Age of Degenerative and Age of Man-Made Diseases (1920 to 1960) (Omran,1971, 2005; Popkin, 2002). To these transitions I would add the "Age of Human-made Disease, overlapping the previous age and running from about 1920 to the present day.

**The Age of Pestilence and Famine** is characterized as a period of high and shifting mortality rates in the population reducing the potential for sustained growth. This is a period of epidemic infections such as tuberculosis, cholera, typhus, smallpox, famine, and unsanitary conditions and diseases transmitted from other animals (zoonotic diseases). The average life expectance is between 20 and 40 years and childbirth mortality is high.

**The Age of Receding Pandemics** can be described as a period of mortality decline and as epidemics peak and then decline, so does the mortality. In urbanized areas the average life expectancy improved to 30 to 40 years. For Fourth World communities coming into closer contact with urbanized, industrialized societies, tuberculosis, smallpox, measles, cholera and similar "Age of Pestilence" diseases persisted while zoonotic diseases begin to decline. Life expectancy is about 30 to 50 years. Population begins to grow.

**Age of Degenerative Disease** including heart diseases like cancers and strokes begin to dominate populations in industrialized societies, yet life spans improve to 70 years and more. Among indigenous societies life expectancy is still hampered by pandemics and diseases associated with the "Age of Pandemics" due to proximities to industrialized societies and expansion of industrialized societies into indigenous territories.

**Age of Human-made Disease** includes the rise of chronic disease such as diabetes, obesity, new cancers, hypertension and associated heart disease, chronic kidney disease, and malnutrition, wasting, low child birth weights and, for increasing numbers of women outside industrialized societies, iron deficiencies and other micro-nutrient deficiencies including zinc, manganese and copper (Cohen, Tirado, Aberman, & Thompson, 2008) due to industrial development, environmental damage, industrialized food production, and population development pressures. Industrial societies develop management approaches to reduce the adverse effects of the factors producing chronic diseases, but indigenous people are unable to prevent the expanding interventions into their societies.

The proposition of epidemiological transition is postulated on the premise of "progressive time" that defines conventional scientific analysis (time occurring from the "primitive to the advanced in perpetual motion") as contrasted with "spiralist time" (time occurring with a past, present and future all occurring simultaneously) that is more typically characteristic of time conceived by Fourth World peoples (Atleo, 2004, 2005; McDonough, 2010; R. Rÿser, 2015; R. C. Rÿser, 1997; Stone, 2004). The Fourth World health reality appears to be reflective of all transitions from pre-Neolithic to contempo-

rary—thus suggesting the indigenous measure of time of simultaneity is an important distinction to understand. In other words, many conditions typical of each of the transitional phases do appear among indigenous peoples though among urban populations most have lapsed.

Orthodox, reductionist researchers performing inquiries for the World Health Organization, the Science and Research Board, New Delhi, India and the Department of Community Medicine in Kerala State, India, generally conclude that deteriorating chronic health conditions among Fourth World peoples are due to "poverty, lack of cleanliness, infrastructure inadequacy" (Nalinam M., 2016) and lack of education. The solution to the growing levels of chronic disease is repeatedly stated by researchers as a need to "change behavior" in connection with food consumption and physical exercise. For indigenous peoples it may not be accurate to suggest that "behavioral change" is appropriate. Instead, the advances of industrial development and urbanization into indigenous peoples' lives and territories may be the culprit that requires change.

## Disaggregation of Fourth World Health Data

States' governments and their subsidiary institutions collect and maintain social, economic, and health data descriptive of the populations they serve. These figures are generally "global" unless specific cohorts are defined in terms of specific circumstances. In the United Nations World Conference on Indigenous Peoples Outcome Document (2014) the consensus document committed all states' governments to the proposition that social, economic and health data specifically descriptive of each indigenous population within their boundaries must be "disaggregated" as discrete information (UNWCIP, 2014). As of the publication of this article, no state in the world has as yet undertaken to separate indigenous peoples' social, economic and health data in databases or any other form.

Perhaps the closest researchers may get to disaggregated data about the health and nutrition of indigenous peoples is to focus on the work of the nutritionist Dr. Harriet Kuhnlein[2], director of the Centre for Indigenous Peoples' Nutrition and Environment (CINE) at McGill University in Montreal, Canada. Her work over more than 35 years has documented traditional foods, their nutritional benefits, the community health and social and environmental conditions of specific indigenous populations conducting research on the ground and in the communities. In recent years Kuhnlein's team of researchers has contributed to major studies on targeted populations under the aegis of the United Nations Food and Agriculture Organization. Perhaps the greatest benefit of these studies is that they specifically test the nutritional values and uses of traditional foods for each indigenous community. It becomes possible then, to examine the health, nutritional and medicinal values of plant-based and animal-based foods and medicines used by particular indigenous societies in many different ecological and environmental circumstances. The data provid-

[2] Harriet Kuhnlein is a nutritionist based with the Centre for Indigenous Peoples' Nutrition and Environment (CINE) at McGill University, Montreal. Her research with Indigenous Peoples spanning more than 35 years is participatory, and includes many cultures of Indigenous Peoples in various parts of the world. Recent publications engage twelve diverse cultures of Indigenous Peoples and have the overall intent to provide evidence that biodiversity inherent in traditional food resources of Indigenous Peoples foster food security and good health. These local food systems can form the basis of health promotion actions and contribute to poverty reduction; they should be environmentally protected.

ed by Kuhnlein's team of researchers can open the door to more detailed consideration of the relationship between the consumption of traditional foods and medicines over time, commercial influences such as processed foods and urbanization, and the apparent increased incidence of chronic diseases in Fourth World communities.

Kuhnlein's team notes the important connection between culture, traditional knowledge and the exercise of community control over plant-based and animal-based foods and medicines. The team lists five factors (Kuhnlein et al., 2013):

- access to, security for, and integrity of lands, territories, natural resources, sacred sites and ceremonial areas used for traditional food production;

- abundance, scarcity and/or threats regarding traditional seeds, plant foods and medicines, food animals, and the cultural practices associated with their protection and survival;

- use and transmission of methods, knowledge, language, ceremonies, dances, prayers, oral histories, stories and songs related to traditional foods and subsistence practices, and the continued use of traditional foods in daily diets;

- Indigenous Peoples' capacity for adaptability, resilience and/or restoration regarding traditional food use and production in response to changing conditions;

- Indigenous Peoples' ability to exercise and implement their rights to promote their food sovereignty.

It will be necessary to consider elaborating on the fourth factor concerning adaptation to change by detailing the iatrogenic effects of conventional medicine and nutritionists as well as human-caused environmental, biodiversity and climate changes beginning in the 1750s with the Industrial Revolution.

Kuhnlein's response to the health and nutrition damage giving rise to growing chronic disease problems in indigenous communities is to encourage the restoration of traditional food sources and the consumption of plant and animal- based foods and medicines historically associated with the indigenous community. The Center for World Indigenous Studies advanced the same proposition through a series of "Culture, Foods and Medicines" workshops in the late 1990s premised on the concept that restoring the use of traditional foods and medicines would reduce and eliminate chronic diseases. Studies by the Center for World Indigenous Studies found that in several communities the chronic disease symptoms actually declined.

While there is agreement between Kuhnlein's CINE and the Center for World Indigenous Studies concerning the benefits of restoring traditional food systems for specific communities, recent investigations raise the possibility that, while restoration of traditional foods actually does improve community health and reduces the incidence of chronic diseases, other factors may now intervene to undermine the premise of restoration. The rapidly increasing levels of CO2 in the earth's atmosphere may work to over energize the photosynthetic processes particularly C3[3] and to some extent C4 plants resulting in greatly increased sugar concentration in plant cells and reduced proteins, micronutrients and vitamins. The result is that many C3 plants convert into sources of sugars that can contribute to chronic diseases.

Forest and jungle animals and commercially raised animals may also consume plants (both traditional plants and cultivated plants) containing higher levels of sugars. When human beings consume the animal flesh the animal metabolic reactions to higher sugars and lower protein and micronutrients can be passed on to human beings—affecting human health and nutrition. The result may be that when humans eat animal flesh, the levels of nutrition may also decline.

## Obtaining Health Data Directly from Indigenous Nations

Because the aggregated health data collected by state institutions is absent, the Center for World Indigenous Studies is conducting The Indigenous Peoples' Health: Effects of Elevated Atmospheric CO2 on Plant and Animal based Foods and Medicines research study, relying on the Kuhnlein on-site data for six nations located in a variety of ecosystems in the African continent, Asia and the western hemisphere. The conventional scientific community and indigenous scientific community have conducted inquiries into the effects of "elevated CO2" in the atmosphere on the nutritional and medicinal values of plants and animals. More than 1,000 studies focusing on primarily cultivated C3 plants have been conducted under the sponsorship of corporations and state institutions as well as indigenous health agencies. The CWIS recognizes that numerous methodologies and target plants and some animals have been employed and the principal method for cross study evaluation is usually a meta-study. CWIS has collected several meta-studies and single focus studies seeking to apply a traditional knowledge system to evaluate the effects of elevated atmospheric CO2 on the health of peoples reliant on traditional plants and animals for food and nutrition.

The five nations selected for the CWIS inquiry include the Nuxalk Nation in western Canada, Awajun in northern Ecuador, Karen Nation in eastern Burma and western Thailand, Bhil in western India and Igbo in southeastern Nigeria. The choice of these nations is based on the completeness of data collected and the range of ecosystems represented. Plants and the animals consumed by indigenous peoples fall into three broad metabolic categories designated by virtue of the photosynthetic process of fixing carbon from the atmosphere turning CO2 into organic molecules such as carbohydrates, fats and proteins. The vast majority of the world's plants (85%) are classified as C3 including common plants such as spinach, peanuts, cotton, wheat, rice, barley, and most trees and grasses. These plants extract carbon from the atmosphere and then release 25% of that carbon back into the atmosphere—a process called photorespiration—affecting the water retention of the plant. This is due to the structure of cells in the plants. Three percent of the world's plants are C4 plants including mostly flowering plants, including maize, sugar cane, millet, sorghum, pineapple, daises and cabbage. These plants retain most of the CO2 taken from the atmosphere. A third group of plants is classed as CAM (crassulacean acid metabo-

[3] Eighty-five percent of all plants including commercially grown wheat, rice, soybean, grasses, spinach and similar broadleaf plants, barley, rye, berries, nuts and all trees are among the C3—the primary food source for the planet. These plants do not have the adaptation necessary to reduce or prevent photorespiration that causes the plant to extract oxygen instead of carbon dioxide from the atmosphere causing some of the energy from photosynthesis to be wasted. C4 plants have different cell types permitting them to separate the initial fixation of carbon dioxide and the Calvin Cycle and thus preventing photorespiration. CAM plants (Crassulacean acid metabolism) reduce exposure to photorespiration and save water in their cells by actively separating processes between day and night.

lism) that efficiently store water. They include cacti, sedum, jade, orchids, and agave. The geographic location, ecology and biodiverse community strongly influence which of the plant metabolic categories apply. The central issue of importance with these three categories is the effects of elevated CO2 in the atmosphere on the nutritional and medicinal values of the plants. Similarly, the nutritional values that may change with higher levels of CO2 absorption can affect the nutritional values of animal (sea and terrestrial) consumption. The effects of elevated CO2 in the atmosphere on the nutritional and medicinal values of plants may be a hidden factor in the increased levels of chronic diseases experienced by Fourth World communities.

The Center for World Indigenous Study seeks to assess the degree to which elevated CO2 in the atmosphere affects both cultivated and traditional plants and animals in terms of nutritional and medicinal values, and thus the health of Fourth World communities. The CWIS study focuses on several nations that are historically or currently dependent on traditional plant and animal foods found in their biodiverse environment. Each nation is experiencing increased levels of chronic diseases. A brief description of each nation follows.

## Nuxalk

Nuxalk is a nation located on the southwest coast of Canada on the Bella Coola River system with a population of 3,000 people. Talyu, Suts'lhm, Kwalhna, and Q'umk'uts are the nation's main villages located on rivers flowing through the nation's territory[4]. Nuxalk consider themselves a "fish people" with their significant historical and contemporary reliance on salmon, oolichan, and seal as major contributors to their diet, material wealth and their cultural practices. According to the Food and Agriculture Organization, the Nuxalk are 30% reliant on 67 species and varieties of plants and animals (Kuhnlein, Erasmus, & Spigelski, 2009). Cultural changes and health problems became significant factors in Nuxalk life due to reduced food types and increased reliance on non-Nuxalk influences. These included deforestation, which caused food sources to become more remote from main villages, along with intensive interventions into Nuxalk villages and rivers by industrial development by the Canadian government.

The Nuxalk are reported to be suffering from alcoholism, poor dental health, obesity, diabetes and conditions associated with high-risk infants. These pathologies are now full-blown among the Nuxalk despite the fact that prior to 1950 there was no evidence of any of these conditions. Prior to 1950 the Nuxalk population relied primarily on local foods and medicines from the surrounding environment, rivers and the ocean (Kuhnlein et al., 2013, 2009).

Typically, before Canadian interventions Nuxalk experienced a balanced diet without the pathologies by consuming wild greens and berries [e.g., black hawthorn, blackcap raspberry, crowberry, kinnikinnick berry, huckleberry, rose hips and thimbleberry], hemlock inner bark, wild game (moose, deer, rabbit) and fishes (flounder, herring roe, salmon (five varieties) dried, smoked and raw ooligan (also oolichan) and the grease extracted from ooligan, and trout. These plant and animal species and varieties provided the full complement of vitamins, minerals (macro and micro) as well as carbohydrates, fats and proteins supporting early childhood, maternal and adult diets (Kuhnlein et al., 2009, 35).

[4]Retrieved on December 15, 2018 from https://nuxalknation.ca/about/

But, by the 1950s and 1960s young girls no longer consumed the many berry species, hemlock inner bark, herring, sea urchins, abalone, mussels, seal and mountain goat and rabbit (Kuhnlein et al., 2009. 34). The generational shift from preferences for traditional foods to reliance on imported foods and medicines seemed to significantly contribute increased levels of chronic disease (obesity, Type 2 Diabetes, heart disease, etc.). While the chronic pathologies have increased throughout the Nuxalk population, reliance on many traditional foods continue even though environmental contaminations and reduced harvests have undermined consumption. The salmon, trout, herring, cod species, salmon eggs, some berries that are accessible (blackcaps, wild raspberries, salmon berries, soap berries) thimbleberry and salmon berry sprouts, seaweed, Labrador tea, cow parsnips, deer, moose, duck and grouse continue to be consumed albeit in lesser quantities and less frequently.

Since the Nuxalk are now 30% reliant on traditional foods, and the remainder reliant on commercially produced, imported foods and medicines, it is possible that this reduced reliance is wholly responsible for the increased levels of chronic disease. But, it may also be a concern that the wildcrafted foods that continue to be consumed are of lesser nutritional and medicinal value owing to environmental, ecological and climate changes.

The bulk of Nuxalk plant-based foods are C3 type plants, which renders them more vulnerable to photosynthetic processes that reduce productivity and increase sugars. The process may lower protein and micronutrient content due to elevated $CO_2$ in the atmosphere and consequent effects of adverse photorespiration.

## Awajun

The Awajun nation of 8,000 people is located in an 86 square mile territory on the Marañón River in 52 communities at the northern border of Peru with Ecuador[5]. The Awajun are 93% reliant on 223 species and varieties of plants and animals in their territory (Kuhnlein et al., 2009). While the Peruvian life expectancy average for both sexes is 75.5 years, it is notable that 50 percent of the Awajun die before reaching 40 years, though the population strength appears to be maintained as a result of high fecundity with more than 7 children born to each woman. Their primary health pathologies include early childhood deaths (where 25% die before the age of 9), parasitosis, malnutrition, stunting and anemia attributable to changing "ecological, cultural and food systems" (Kuhnlein et al., 2009).

The tropical rain forest environment is conducive to the wild crafted and cultivated foods on which the Awajun depend. The Awajun people are agriculturalists as well as managers of the rainforest producing the foods on which their diet depends. They produce sugar cane, coffee, papaya, achiote, pineapple, sacha papa, sweet potato, red peppers and a wide range of medicinal plants including ginger, garlic, coriander, and lemon grass. Fruit trees are cultivated to produce arazá, carambola, aquaje, pijuayo and cacao.

## Karen

The Karen nation of about 9 million people is scattered in Burma along the eastern border in the states of Kayah, Shan, Ayeyarwady, Southern Kaw-

[5]Retrieved on December 12, 2018 from http://www.orgbyvio.com/awajun/

tholei and in western Thailand where they are under frequent armed attacks and village burnings by the Burmese military. Hundreds of thousands of Karen fled their villages in Burma to internally displaced persons' camps (IDP) and to refugee camps on the western border of Thailand beginning in 1984. The study community is Sanephong with a population of 661 inhabitants in 126 households located in the Thungyai Naresuan National Wildlife Sanctuary northwest of Bangkok, Thailand. The remote village is only accessible by a mountainous and muddy trail or by four-wheel-drive vehicles through muddy paths. The Thai government heavily restricts the Karen community in Sanephong as to the plants and animals that can be harvested due to the wildlife sanctuary designation of the areas around the village. Food sources are then a combination of farming and gathering from four specific cultivation, and gathering locations ranging in size from 4.8 hectares to 320 hectares. In these locations families grow bananas, mangos, jackfruits, gourds, pumpkins and wet rice. Fresh water fish are taken with other aquatic animals (crabs, shells, shrimp, frogs) along with plants and vegetables (on the banks) from the Kheraw-Khi, a perennial stream from nearby mountains. Rice is the dominant base food on which members of the village rely.

The Karen (Burma, Thailand) are 85% reliant on 387 species and varieties of plants and animals. Researchers identified about 387 traditional food species and varieties where 17% were animals and 83% were plants. Of the animals, ducks, cows, buffalo and goats are domesticated, and 51 rice and root varieties, 89 vegetables and 37 fruits are cultivated while 126 varieties are harvested from the forest.

The village of Sanephong, unlike the refugee camps where more than 150,000 Karen are held in eight locations along the Thai eastern border, is organized with a primary school that promotes health and nutrition and offers gardens, a milk program, daily lunches and support with iodized cooking salt and weekly iron supplementation. The village also has volunteer health workers responsible for primary health care. Generally, the village of Sanephong depends on foraging and domestication with the purchase of food increasing as the market economy has been entering the village. Still, locally grown rice has remained the main source of food energy while animal sources for protein are available but not abundant. Fruits, vegetables and some wild game, such as green frogs and crickets, contribute to the bulk of macronutrient support. Carbohydrates constitute more than 70 percent of the total energy intake for Karen children in this village. While infants appear to receive sufficient nutrition from breast milk, children aged 2-12 were found to have deficient intake of vitamin A and vitamin C; and iron and calcium intakes were also found to be very low (Kuhnlein et al., 2009, 180). Significant fruit consumption for children has proved problematic with many experiencing abdominal discomfort and diarrhea in infants.

## Bhil

Bhil are the largest pre-Aryan indigenous nation in India with a combined population in excess of 16 million people located in southeastern Pakistan and western India. Part of the Bhil population is located in mountainous regions in Madhya Pradesh, Maharashtra, Gujrat, Karnataka, Tripura, Andhra Pradesh, Chhattisgarh and Rajasthan states and Sindh state in Pakistan. The population is mainly engaged in farming drawing on plants

(greens, roots, fruits) and animals including fish and deer from nearby rivers and forests. The Bhil population located in the Dang district of Gujarat state is the primary data source with a population of 11,500 people in 53 villages. Neighboring indigenous peoples include Kolchas, Kotwalias, Kuknas and Warlis. A quarter of the Bhil population is gainfully employed earning an average of $500 annually with fishing and hunting and gathering 95 species and varieties of animals and plants in the forest is usual (Kuhnlein et al., 2009, 212).

The Bhil in the Dang District cultivate cereals such as amaranth, millet, rice, sorghum wheat and maize. Fish and other seafoods include shark, mandeli, duck, crab, and other smaller river fish including ravas, kokil zinga and muru. Cultivated vegetables include mushroom, bamboo, red pumpkin, bottle gourd, scarlet runner beans, eggplant and fenugreek. Bhil consume animal-based foods from cows, goats, rabbits, rat, wild pig and monitor lizard and poultry including pigeon, whistling kites, woodpeckers, parakeets and parrots, as well as traditionally captured ghuvad, chakvat, and titar. Fruits, nuts, seeds pulses and legumes play a major role in the Bhil diet including: Sapodilla fruit, Custard apple (sweetsop), jackfruit, Papaya, gooseberry, wild figs, tomato, mango and guava; and pulses include red gram dhai, field beans, soybeans, lentils, peas, cow pea; and roots are an important part of the diet including Elephant foot (yam), Colocasia, spinney yam, sweet potato, potato and red tubers.

An in-depth study of India's chronic disease profile concluded " that chronic diseases will account for slightly less than three-quarters of all deaths in India by 2030" (Patel et al., 2011).

"Generally, tribals consume foods like wild tubers and flowers, for which information is not available in nutrition composition tables. Thus, information of these foods was not reflected in the consumption of various nutrients" (Laxmaiah et al., 2015).

"Multivariate regression analysis showed that age, education, HH wealth index, tobacco use, alcohol consumption, high BMI, abdominal and truncal obesity are risk factors for hypertension among tribal men and women in India. Higher risk of hypertension among illiterate tribal women was similar with findings reported by other studies" (Laxmaiah et al., 2015). "The use of natural substances, particularly plants, to control diseases is a centuries-old practice that has led to the discovery of more than half of all modern pharmaceuticals" (Priyanka & Shrikant, 2014)

## Igbo

The Biafra Nation includes Igbo with an estimated 32 million along with the Efik, Ibibio, Annang, Ejagham, Eket, Ibeno and the Ijaw located in southeastern Nigeria on the Atlantic Coast and bordering the Republic of Cameroon. The Igbo led a secessionist war against Nigeria (that had itself only recently become a state after British colonial rule) to establish the Republic of Biafra between 1967 and 1970. Their Republic was recognized by Gabon, Ivory Coast, Tanzania and Haiti and received aid and support from seven other countries including France, Norway and Israel. The war devastated the Igbo resulting in more than 2 million people killed. This background is directly relevant to understanding the focus of the Kuhnlein study that focused on eight communities randomly selected in four states: Ohiya/Huhu in Abia State and Ezinifite/Aku in Anambra State, Ubulu-Uku/Alumu in Delta State and Ede-Oballa/Ukehe in Enugu State. Thus these Igbo communities are included in the CWIS study.

The combined population of these communities is estimated to be in excess of 500,000 people with the Ede-Oballa comprising the smallest at 12,447.

The geographic and environmental character of Igbo areas may be best described as plains that are less than 200 meters above sea level. The land experiences rainy seasons with variations from year-to-year. Consequently, there are essentially two seasons: rainy, and hot and dry.

The health status of the general populations in the whole state of Nigeria described 42% of the children as stunted, 25% as underweight and 9% wasted. In the southeast the Igbo were described as being characterized as 20% children stunted, 5% wasted and 8.5% underweight. The Igbo population described in 1993 was experiencing micronutrient deficiencies specifically associated with limitations of Vitamin A. Iodine and zinc deficiencies are associated with as high as 27 percent of the mothers and pregnant women in the Igbo population. These deficiencies seem to have persisted despite iodine and β-carotene being readily available in three leaf yams, yellow hams, and zinc and iron in banana's plantain, bread fruits, cashews and legumes. Stunting and wasting can be attributed to dietary deficiencies in nursing mothers as well. A food preparation such as Achicha (dried cocoyam mixed with pigeon pea, oil bean, palm oil and green leafy vegetables) is rich in iron, zinc, β-carotene, folate and copper—all significant counters to dietary deficiencies. Okpa is a dish with Bambara ground nut flour paste mixed with palm oil, pepper, salt and spices providing protein, iron, niacin, magnesium and β-carotene. These and numerous other preparations provide ample evidence that micronutrients are available in the diet. However, the question remains whether these micronutrients are in sufficient quantity per serving to provide for full nutrition. Their nutritional value may be declining.

While these health status factors reflect dietary conditions, it is the case that the Igbo use a total of 220 species and 400 varieties of foods (Kuhnlein et al., 2013, 2009). Twenty-one (21) species of starchy roots and tubers, 20 legumes, 21 nuts/seeds, 116 vegetables, 12 mushroom varieties and 36 fruits have been documented in southern Nigeria. Igbo territory in the southeastern part of Nigeria depends largely on agriculture and fishing while peoples in the north emphasize farm production, meats and fruits.

## Foods from biodiverse environments

The Food and Agriculture Organization of the United Nations (FOA) sponsored studies resulting in intensive documentation of foods and their nutritional values used by 13 selected indigenous peoples located in the western hemisphere (4 nations), Africa (2 nations), Sub-continent of India (2 nations), Asia (2 nations) and Pacific Island (1 nation). The studies were carried out by the Center for Indigenous Peoples' Nutrition and Environment (CINE) offices in Quebec, Canada and researchers from the FOA. These studies provide the first evidence of nation-specific nutritional and health data that under conventional circumstances would not be collected or would become embedded and thus invisible in state population studies.

The world's Fourth World peoples may depend up to 80% on non-commercial or non-cultivated plant-based and animal-based foods and medicines for their daily diet. This is generally true despite the fact that growing numbers of Fourth World peoples have been forced by states' government policies that

"favor abandonment of traditional crops" (Rodrigo, Andrade, Orbe, & Terán, 2018) from their traditional territories into closer proximity to towns and outposts and have as a result become dependent on commercially processed foods and medicines resulting in "transition nutrition" directly affecting health responses. Fourth World communities' report evidence of growing increasing levels of chronic diseases.

## Limitations of Conventional Research

Conventional or orthodox academic, political, and public media commentary centered on the term "climate change" primarily discusses in terms of infrastructure and economic costs associated with effects such as rising sea levels, changes in global food supply, relocation of communities, and mitigation strategies. Little emphasis is placed on the repercussions that human-induced changes have on climate—and the major effects the elevated atmospheric CO2 levels have on human health. While there is an emerging body of orthodox scientific literature reporting research results about the effects of elevated carbon dioxide levels (CO2) on plant-based and to a minor extent animal-based foods and medicines, the bulk of that research tends to focus on commercially/agriculturally produced plants and animals with an essentially economic bias. Some orthodox researchers conducting meta-analyses of extant literature note with concern that elevated CO2 and other greenhouse gases in the atmosphere have negatively affected cultivars of various commercial crop species resulting in serious chronic disease consequences for human beings (Dietterich et al., 2015a; Loladze, 2014; Thompson & Cohen, 2012). Researchers tend to agree that peoples dependent on agriculture are particularly vulnerable to the effects of climate change on nutritional values of plant-based and animal-based foods. The particular effects of CO2 levels on traditional foods and medicines harvested from forests, prairies, jungles and rivers on which more than a billion Fourth World people depend for nutrition and health may be of greater significance. The dearth of information on the changing nutrition (protein, micronutrients, bioavailability) of wild plants and animals, which constitute from 40% to 80 of Fourth World peoples' diet and sources of medicine, suggests the need for further research.

As distinct political nations encapsulated by states, Fourth World nations—and the bio-culturally diverse regions they represent—hold roughly 80% of the world's biodiversity. Collectively, CWIS estimates there are 1.3 billion people representing 6,000 distinct Fourth World nations ranging in size from 100 people to 25 million people throughout the world. Their long histories of cultivating mutually-beneficial relationships with the ecological niches they inhabit, place them in both a vulnerable position, with regards to climate change; and in a strategic position, with regards to holistic and effective approaches towards mitigating its effects.

Nearly every ecosystem has been altered so that plants and animals can be used as food and medicine, as well as Bharucha & Pretty write, "[T]he mean use of wild species is 120 per community for indigenous communities in both industrialized and developing countries" (Bharucha & Pretty, 2010). In Igbo communities in southeast Nigeria the people obtain 96% of their daily energy from 220 possible species or varieties of plant and animals sources. The Awajun in northern Peru obtain 93% of their daily energy from as many as 223 plant and animal

species and varieties (Kuhnlein et al., 2009). But with the quantity, quality, and accessibility to wild foods diminishing—as a result of climate change, overdevelopment, and conservation-exclusions—it becomes necessary to evaluate the role that wild foods play/will play in nourishing the physiological and cultural realities of Fourth World peoples and beyond.

Recent studies (Dietterich et al., 2015b; Loladze, 2014; Ziska et al., 2016) suggest an alarming possibility that through human cultivated plant and foods and plant/animal foods and medicines obtained from the biodiverse environment, the changing atmospheric composition may be radically altering the nutritive and medicinal values on which human beings depend from these sources.

Indeed, it may be that the levels of chronic diseases suffered by Fourth World peoples may be a significant marker that, though indigenous peoples generally obtain an average of 80% of their daily nutrition and medicines from the wild, the changes in plant and animal nutritive composition may be changing significantly. The changes may be directly affected by the rapid elevation of CO2 and other greenhouse gases in the atmosphere that alters the photosynthetic actions in plants. These changes may be reduction of proteins, micronutrients, and vitamins and increased levels of sugars and other carbohydrates. The consequence could be that even though there is an increased consumption of favored plant and animal based foods, the actual level of nutrition may decline. The result could be increased stunting, and wasting, low birth weights and early childhood deaths due to micronutrient reductions, increased chronic diseases such as Type 2 Diabetes, heart disease, kidney disease and cancers due to increased sugar levels.

**It is within this context that the following research questions frame the research study:**

**Q1:** What is known about increased atmospheric CO2 on wildlife (plants and animals) used for food, medicinal and pharmacological purposes by Fourth World peoples?

**Q2:** What is the effect on indigenous health? Global health in general?

**Q3**: Given that CWIS advocates returning to wild foods and medicines are we urging Fourth World peoples towards more harm than health?

**Q4:** What are the alternatives? Since states cannot deal with this issue, how can Fourth World nations address these changes?

## Theoretical Framework

Fourth World Theory (FWT)[6] in research states that the concepts of comparison, relational reasoning, balance between contending forces, and an equality of kind (that human beings are part of all living things and not the dominant living thing) will— when applied in life and thought— ensure comity between peoples, between peoples and living nature, and with the forces of the cosmos. If human demands exceed the capacity of the natural world to reproduce a destructive imbalance causes the destruction of life. Studies of wild foods, nutrition, ethno-botany, and physical, emotional, and cultural health are all within the frame of Fourth World theoretical inquiry (Ryser, Gilio-Whitaker, & Bruce, 2016). Fourth World Theory is rooted in systems of knowledge such as those birthed in Sub-Saharan

[6]Fourth World Theory asserts that history, memory, and thought processes are multi-dimensional— where two-dimensional thought (linear past progressing to the future, fatalistic, cyclical, or providential) is in reality seven dimensional. Tracing thought diagrammatically the process is more like a spiral where motion and change move in all directions simultaneously in time and space.

Africa (Kongo Knowledge System), the Western Hemisphere (Anahuac Knowledge System, Tsawalk Knowledge System, Anishinabek Knowledge System) and northern Europe (Saami Four Winds). These systems, though independent, share common conceptual foundations based in the metaphor: Four Directions.

It is this theory that serves as the foundation for the research study the Center for World Indigenous Studies started in December 2017 to evaluate the extent to which elevated CO2 levels in earth's atmosphere may contribute to the incidence of preventable chronic disease among indigenous peoples.

Fourth World Theory asserts that history, memory, and thought process are multi-dimensional—where two-dimensional thought (the linear past progressing to the future, fatalistic as in predordained, cyclical as in repetition or providential as in ordained by God) is in reality seven dimensional (R. C. Rÿser, 1997). Tracing thought diagrammatically the process is more like a spiral where motion and change move in all directions simultaneously in time and in space. Fourth World knowledge systems have typically illustrated these epistemological conceptions in another metaphoric shape typically rendered as the Four Directions. Yet it is an incomplete statement to assert that there are only four directions when in reality there are seven directions with an infinite number of intermediate points on a "circle cross" when each of the points on a cross indicate four directions associated with solar and lunar movements, the center point where all four lines meet in the middle and unmarked lines extending outward from the top and bottom of the center point provide the above and below dimensions: equaling seven dimensions from four directions. The diagrams are indeed metaphoric as in the Purépeche Agrocosmology diagram ***(See Figure 1)*** that provides essential information for plant, meteorological, cosmological and environmental guidance. The Congo Cross ***(See Figure 2)*** is similar to the Purépeche four directions diagraph also serves as a practical tool for aiding in noticing, recognizing, explaining and predicting material and immaterial phenomena of which human beings are an intimate part.

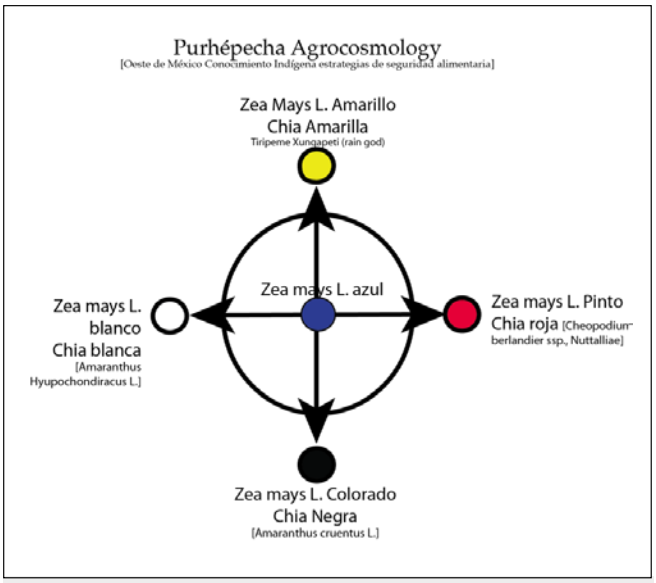


**Figure 1:** Purépeche Four Directions Cosmogram – México

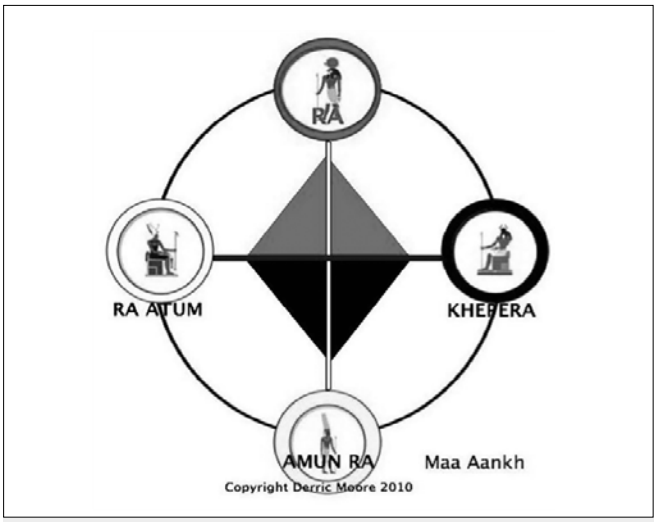


**Figure 2:** Congo Cross

Fourth World peoples' knowledge systems vary from locality to locality, reflecting the cultural uniqueness that arises from their dynamic and evolving relationships with the land, sea, and the cosmos (Ryser, 2012). These knowledge systems differ from positivism in that they conceive of many different ways to apprehend truth applying different scientific approaches focusing on relationships between observable and repeated phenomena. An illustration of relationship mapping is depicted in Figure 1 where the Purhépecha in Mexico provide the metaphoric "four directions" showing the relationship between directions, the cosmos, plants, animals, and human uses by season. There is not just one form of indigenous knowledge, there are many as illustrated in the relational "four directions" image from the Congo in Figure 2. While the sources and methods for acquiring knowledge differ, the themes of change and relationships occur repeatedly—thus informing the methodology of the CWIS study.

Knowledge systems such as these constitute sciences that contribute to conventional science as conceived in 17th century Europe in which "humanism produced a version of human nature by tethering to human-ness the requirement of rationality" (Watson 2008, 258). Fourth World sciences may be comparable or of greater importance than orthodox sciences in potential benefit to humanity when addressing complex problems such as the effects of changing climate on earth's living populations. Long-established Fourth World sciences in the fields of plant and animal behavior, nutrition, medicines, as well as non-domesticated as well as domesticated foods and medicines, harvesting, hunting and processing knowledge, for example, formed the foundations of orthodox allopathy, homeopathy, nutritional practices, psychology, pharmacology and the "natural sciences." Fourth World knowledge systems express explanations, concepts, ideas, practices and restorative relief in virtually all scientific domains and as indicated over time directly and indirectly informed Western science as a whole.

One indigenous knowledge system embedded in Fourth World Theory originates with the Nuu-chah-nulth (Pacific Coast of Vancouver Island, Canada) based in the concept of tsawalk, meaning, "all is one." In Tsawalk, A Nuu-chah-nulth Worldview, Richard (Umeek) Atleo (2004, 2005), offers a locally embedded yet broadly relevant perspective on the ontology and epistemology of global ecological crisis. Tsawalk makes no distinction between physical and metaphysical (spiritual) processes—every aspect of the world is connected through energy and spiritual relations—significantly informing Fourth World Theory. The Anahuac knowledge system (R. C. Rÿser, 2015) is possibly the grandmother of knowledge systems in the Western Hemisphere rooted in México's civilizations extending to more than 3,500 years. This system of thought also informs Fourth World Theory with practical conceptions explaining and depicting material and immaterial realities (Lara, 2007; R. C. Rÿser, 1997). Living relationships in the Anahuac system, just as in the Tsawalk system, require moral accountability among all sentient beings (plants, animals, humans), including the Earth, the Cosmos and—by extension—Earth's climates.

With regards to climate change—such as the effects of elevated CO2 levels in the atmosphere on wildlife used for food, medicinal and pharmacological purposes by indigenous communities—Nietschmann (1994) argues that it is imperative to include a diverse set of cultural responses and scien-

tific know-how in order to holistically and effectively develop and implement policies that will secure livelihoods for all people. Technological innovation can help mitigate some of the challenges humans face. But if that innovation comes at the cost of an increasingly narrow list of solutions, humans will learn a painful existential lesson. In order for long-term systemic change to occur, the full and effective political participation of those who have a historically proven track record of sustainability must be implemented.

## Methodology

In this study we apply several concepts offered by Fourth World theory to evaluate, compare, describe and infer the effects of elevated atmospheric carbon dioxide ($CO_2$) levels on the nutritional and health benefits of plant-based and animal-based foods and medicines used by Fourth World peoples collected or otherwise obtained in localities such as forests, jungles, savannahs, prairies, rivers, oceans, deserts and mountainous areas.

Role-based Relational Reasoning is best represented by analogical reasoning, where analogy is an instrument of scientific inquiry and conceptual change applied to discover causal relationships and set of systematic correspondences that serve to align the elements of a source and target. Applied to common human experiences role-based relational reasoning would use an observed phenomenon of ants carrying bits of plant leaf torn from a bush and then carrying the bits in their jaws in single file across a field to their nest and relate by metaphor the observed event to an army of humans carrying supplies to a barracks. Both represent essentially the same phenomenon that can be subsequently described as wires carrying electrical charge from a generator to a light bulb. The analogy draws on the target (ants) to explain the source (electricity) rendering the process of electrifying a light understandable. The elements used to apply analogical reasoning include retrieving a target (observed or factored) and rendering it as a source (analogized), mapping the relationship between the target and the source, and then derive inferences that can lead to various schematics that can lead to observable or factored categories or situations that mirror the original target and source.

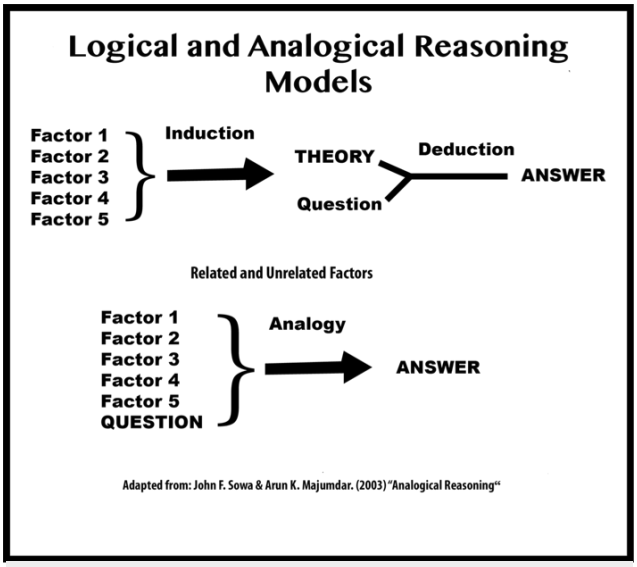


**Figure 3:** Relational Reasoning by Analogy

The complexity of orthodox and Fourth World scientific research may only be understandable through the application of relational reasoning illustrated as inductive and inferential thinking:

Through repetitive application of the logical and analogical reasoning model using different factors the study conclusions are derived. Comparing orthodox and Fourth World scientific research outcomes and Fourth World peoples' consumption of plant-based and animal-based foods and medicines affected by elevated atmospheric carbon dioxide levels

may reveal nutritional and medicinal effects in different populations based on the foods they consume.

Structure of Data Collection depends on a constructed database focused on 15 factors and their associated variables constituting data contained in more than 1,200 orthodox research studies and indigenous research studies focused on plant and animal food identities, locations and uses and the effects of elevated atmospheric levels of CO2 on plant-based and animal-based foods and medicines used by Fourth World peoples.

## Database Structure

The database contains specific identifying factors that can be compared with the specific activity of inferring or documenting specific relationships between the orthodox and Fourth World research results and the effects on plants and animals and ultimately effects on Fourth World population health. The data collected permits relational comparisons between the atmospheric gases and their levels in the atmosphere with effects on the nutritional and medicinal values as may be reflected in changes of protein, micronutrient and vitamin levels over time. The comparisons may include descriptions of early to mid-20th century nutritional values with current levels as set by the data as recently documented in 2009.

| REFERENCE CATEGORY | DATA ENTRY |
|---|---|
| Research literature classification | C3<br>C4<br>CAM |
| Literature publication date<br>Author(s)<br>Professional Field(s)<br>Literature title<br>Publisher<br>Geographic Location | |
| Greenhouse Gas levels | CO2<br>CH4<br>O3 |
| Plant (F=food, M=Medicine, B=Both | C3 – F/M/B<br>C4– F/M/B<br>Ce– F/M/B<br>Fungi – F/M/B |

| REFERENCE CATEGORY | DATA ENTRY |
|---|---|
| Animal Plant (F=food, M=-Medicine, B=Both | Insect/Bug – F/M/B<br>Mollusk– F/M/B<br>Mammal– F/M/B<br>Reptile– F/M/B<br>Fish– F/M/B<br>Other– F/M/B |
| Method of Inquiry<br>Nutritional Change<br>Medicinal Change | Free Air<br>Enclosed |
| FW nations Affected Name<br>Nation/State/Region | |
| Epidemiology | Malnutrition<br>Wasting<br>Stunting<br>Diabetes<br>Heart Disease<br>Cancers<br>Other |

The application of relational reasoning based in Fourth World Theory may serve to provide a more plausible and certain explanation of the relationship between elevated levels of atmospheric carbon dioxide on the nutritional and medicinal values of cultivated, domesticated, and traditional plant-based and animal-based foods and medicines that has been possible with conventional, reductionist research methods and techniques. The supposition is that the numerous variables that come into play affecting plant and animal nutrition and medicines from numerous studies may employ different methods and techniques requiring a broader, whole data approach. That is what the present study is designed to do. If successful there will be a strong, inferential connection between carbon dioxide levels and Fourth World peoples' health. Ultimately, the study will inform how this may be equally true for virtually all humans on the planet.

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Rudolph Ryser has worked in the field of Indian Affairs for more than thirty-five years as a writer, researcher and Indian rights advocate. Rudolph has taught widely on historical trauma, cultural models of addictions recovery, diabetes and culture, foods and medicine. He is the leading architect of the discipline of Fourth World Geopolitics--the study and practice of the social, economic, political and strategic relations between Fourth World nations and between Fourth World nations and States. He has developed and conducted tribal and intertribal workshops and seminars on health, community organization, self-government, law enforcement, and natural resource management. He has led these programs in the United States, Canada, Australia, Mexico and in Peru in Indian and other indigenous communities. Ryser served as Acting Executive Director of the National Congress of American Indians, and as former staff member of the American Indian Policy Review Commission. He holds a doctorate in international relations and he is the author of Indigenous Nations and Modern States, published by Rutledge in 2012.