2 CLIMATE CHANGE

If the state of Idaho was to initiate a carbon market or a climate change program, it will require a basic understanding of the underlying scientific, technical, organizational, and political issues. The purpose of this section is to explore the current scientific understanding of global climate change and greenhouse gas reduction and carbon sequestration and offset measures. The first step introduces the greenhouse effect and the changes in climate expected to result from increasing atmospheric concentrations of greenhouse gases. The second step is to describe international and national responses to climate change to help Idaho understand the current global-wide position on climate warming. Upon gaining an understanding of global-wide activities and policies, a discussion regarding the alternatives Idaho may choose to address climate change and carbon markets are presented.

2.1 THE SCIENCE

The Earth's climate is maintained or affected by many factors, including radiant energy from the sun, volcanic activity, and other natural phenomena. Human activities, specifically those that result in emissions of greenhouse gases, may affect the climate system by altering its self-maintenance by interjecting an increased level of specific gases. Even though the atmosphere's natural “greenhouse” effect is relatively well understood, there are uncertainties regarding the effects of increased concentrations of greenhouse gases.

2.1.1 The Basis for Climate Change

Energy from the sun drives the earth’s weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural “greenhouse effect.” Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, the earth’s average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is altered by human-generated emissions of greenhouse gases.

Global warming could do more than add a few degrees to today’s average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would likely be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The climate of the Earth is affected by changes in radiative forcing attributable to several sources including the concentrations of radiatively active (greenhouse) gases, solar radiation, aerosols, and albedo reflection factors. Greenhouse gases in the atmosphere are virtually transparent to sunlight (shortwave radiation), allowing it to pass through the air and to heat the Earth's surface. This process, similar to what occurs in greenhouses, where solar radiation enters through the glass, but opaque to terrestrial infrared radiation, in which heat is trapped in the greenhouse. The term greenhouse has been used to a great extent by the media and has stuck, though greenhouses are generally heated from an internal source, generally warmer than the outside air when necessary.

The Earth's surface absorbs the sunlight and emits thermal radiation (longwave radiation) back to the atmosphere. Because some gases, such as carbon dioxide (CO2), are not transparent to the outgoing thermal radiation, some of the radiation is absorbed, and heats the atmosphere. In turn, the atmosphere emits thermal radiation both outward into space and downward to the Earth, further warming the surface.

This process enables the Earth to maintain enough warmth to support life: without this natural "greenhouse effect," the Earth would be approximately 55^{o} F colder than it is today. However, increasing concentrations of these greenhouse gases are projected to result in increased average temperatures, with the potential to warm the planet to a level that could disrupt the activities of today's natural systems and human societies.

2.1.2 Carbon Dioxide and other Greenhouse gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels (coal, oil, and natural gas) for energy is the primary source of emissions. Greenhouse gases are emitted by virtually all economic sectors, including residential and commercial energy use, industrial processes, electricity generation, agriculture, and forestry.

Naturally occurring greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Some human-made compounds, including chlorofluorocarbons (CFCs), partially halogenated fluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorinated carbons (PFCs), are also greenhouse gases. In addition, there are photochemically important gases such as oxides of nitrogen (NOx) and volatile organic compounds (VOCs) that, although not greenhouse gases, contribute indirectly to the greenhouse effect by influencing the rate at which ozone and other greenhouse gases are created and destroyed in the atmosphere.

Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases. Idaho has not done an official greenhouse emission inventory, thus is not ranked or compared by EPA officially. However, initial estimates by EPA (http://yosemite.epa.gov/globalwarming/greenhouse_gas.nsf) rank Idaho 48 out of 51 in carbon dioxide emissions from fossil fuel combustion based on 1990 energy data. Likely, due to its low population, Idaho ranks low in emissions when compared to the rest of the nation. Its potential to offset other state's emissions through carbon sequestration and other related activities, however, could be high.

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30- 150% higher than today's levels.

2.1.2.1 CARBON DIOXIDE (CO_2)

Carbon dioxide, likely the most important of these gases, is involved in a complex global cycle, released from the interior of the Earth via volcanic eruptions, and by respiration, soil processes, combustion of carbon compounds oceanic evaporation. The combustion of liquid, solid, and gaseous fossil fuels is the major anthropogenic source of carbon dioxide emissions. Some other non-energy production processes (*e.g.*, cement production) also emit notable quantities of carbon dioxide. CO_2 emissions are also produced by forest clearing and biomass burning. Atmospheric concentrations of carbon dioxide have been increasing at a rate of approximately 0.5 percent per year (IPCC, 1996). Conversely, it is dissolved in the ocean and consumed during plant photosynthesis. There is approximately 359 parts per million by volume (ppmv) in the atmosphere, which scientists claim to be rising due to human related emissions from burning fossil fuels and forests.

In nature, carbon dioxide cycles between various atmospheric, oceanic, land biotic, and marine biotic reservoirs. The largest fluxes occur between the atmosphere and terrestrial biota, and between the atmosphere and surface water of the oceans. While there is a small net addition of CO2 to the atmosphere from equatorial regions, oceanic and terrestrial biota in the Northern Hemisphere, and to a lesser extent in the Southern Hemisphere, act as a net sink of CO_2 (IPCC, 1996).

2.1.2.2 METHANE (CH_4)

Methane is produced primarily by anaerobic (lack of oxygen) process such as in rice cultivation, ruminant animal digestive processes, decomposition of municipal and animal solid wastes. Methane is also emitted during the production and distribution of natural gas and oil, and is released as a by-product of coal production and incomplete fuel combustion. Methane is removed from the atmosphere reacting with the hydroxyl radical (OH) and is then converted to CO_2.

Increasing emissions of methane reduce the concentration of OH, a feedback which may increase methane's atmospheric lifetime (IPCC 2001).

2.1.2.3 NITROUS OXIDE (N_2O)

Nitrous oxide is produced by both biological mechanisms in the oceans and soils, and by human related activities, such as industrial combustion, vehicle exhausts, biomass burning and fertilizer use. It is destroyed in the upper atmosphere (stratosphere) photochemical reactions involving sunlight.

2.1.2.4 HALOCARBONS (CFCS, HCFCS, HFCS, PFCS)

Halocarbons are compounds containing carbon, halogens, such as chlorine, bromine, and fluorine, and sometimes hydrogen. Chlorofluorocarbons (CFCs), such as halons, methyl chloroform, carbon tetrachloride, methyl bromide, and hydrochlorofluorocarbons (HCFCs), are entirely human produced by aerosol propellants, refrigerator coolants and air conditioners. They are slowly destroyed by photochemical reactions in the stratosphere.

These compounds contribute to stratospheric ozone depletion. Normal processes in the atmosphere both produce and destroy ozone. Approximately 90 percent of atmospheric ozone resides in the stratosphere, where it regulates the absorption of solar ultraviolet radiation; the remaining 10 percent is found in the troposphere and could play a significant greenhouse role. While ozone is not emitted directly by human activity, anthropogenic emissions of these gases influence its concentration in the stratosphere and troposphere.

Under the *Montreal Protocol* and the *Copenhagen Amendments*, which controls the production and consumption of these chemicals, the U.S. phased out the production and use of all halons by January 1, 1994 and phased out CFCs, HCFCs, and other ozone-depleting substances (ODSs) by January 1, 1996.

2.1.2.5 CARBON MONOXIDE (CO

Carbon monoxide (CO) is created when carbon-containing fuels are incompletely burned. Carbon monoxide elevates concentrations of methane and tropospheric ozone through chemical reactions with atmospheric constituents that would otherwise assist in destroying methane and ozone. It eventually oxidizes to CO2.

2.1.2.6 OXIDES OF NITROGEN (NOX)

Oxides of nitrogen (NO, NO_2) are created from lightning, biomass burning (both natural and anthropogenic fires), fossil fuel combustion, normal metabolism, and in the stratosphere from nitrous oxide. They play an important role in climate change processes because they contribute to the formation of tropospheric ozone.

2.1.2.7 VOLATILE ORGANIC COMPOUNDS (VOCS)

Nonmethane Volatile Organic Compounds (NMVOCs) include compounds such as propane, butane, and ethane. Volatile organic compounds participate along with nitrogen oxides in the formation of ground-level ozone and other photochemical oxidants. VOCs are emitted primarily from transportation, industrial processes, forest wildfires, and non-industrial consumption of organic solvents.

2.1.3 Global Warming Potential (GWP)

The potential contribution to radiative forcing of the various greenhouse gases differ dramatically. Accurately calculating the amount of radiative forcing attributable to given levels of emissions of these gases, over some future time horizon, requires a complex and time-consuming task of calculating and integrating changes in atmospheric composition over the period. There is a need for an index that translates the level of emissions of various gases into a common metric in order to compare the climate forcing effects without directly calculating the changes in atmospheric concentrations (Lashof and Tirpak, 1990). This information can be used to calculate the cost effectiveness of alternative reductions, *e.g.*, to compare reductions in CO2 emissions with reductions in CH4 emissions to N2O emissions.

There are indices that account for the direct effects of carbon dioxide (CO2), methane (CH4), chlorofluorocarbons (CFCs), nitrous oxide (N2O), hydrofluorocarbons (HFCs), and perfluorinated carbons (PFCs). One of these indices is called Global Warming Potential (GWP) indices, has been developed in recent years. This also estimates indirect effects on radiative forcing due to emissions of gases that are not themselves greenhouse gases, but lead to chemical reactions that create or alter greenhouse gases.

The concept of global warming potential, which was developed by the Intergovernmental Panel on Climate Change (IPCC), compares the radiative forcing effect of the concurrent emission into the atmosphere of an equal quantity of CO2 and another greenhouse gas. Each gas has a different instantaneous radiative forcing effect. In addition, emissions of different gases decay at different rates over time, which affects the atmospheric concentration. In general, CO2 has a much weaker instantaneous radiative effect than other greenhouse gases; it decays more slowly, however, and hence has a longer atmospheric lifetime than most other greenhouse gases. While there is relative agreement on how to account for these direct effects of greenhouse gas emissions, accounting for indirect effects is more problematic GWPs are used to convert all greenhouse gases to a CO_2e (equivalent) basis so that the relative magnitudes of different quantities of different greenhouse gases can be readily compared. The GWP potential will be an important concept for states in determining the relative importance of each of the major emissions sources and in developing appropriate mitigation strategies. Table 1 shows the IPCC calculated global warming potentials for numerous greenhouse gases.

Table 1. Global Warming Potentials (GWP) and Atmospheric Lifetimes (Years				
Gas	Atmospheric Lifetime	50-Year GWP	100-Year GWP	500-Year GWP
Carbon dioxide (CO_2)	50-200	1	1	1
Methane (CH_4)	12+/-3	21	56	6.5
Nitrous Oxide (N_2O)	120	310	280	170
HFC-23	264	11700	9100	9800
HFC-125	32.6	2800	4600	920
HFC-134a	14.6	1300	3400	420
HCF-143a	48.3	3800	5000	1400
HCF-152a	1.5	140	460	42
HFC-227ea	36.5	2900	4300	950
HCF-236fa	209	6300	5100	4700
HCF-4310mee	17.1	1300	3000	400
CF_4	50000	6500	4400	10000
C_2F_6	10000	9200	6200	14000
C_4F_{10}	2600	7000	4800	10100
C_6F_{14}	3200	7400	5000	10700
SF_6	3200	23900	16300	34900
Source: IPCC 1996				
The methane GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and statospheric water vapor. The indirect effect due to the[production of CO2 is not included.				

The Kyoto Protocol, the international agreement yet to be ratified by enough developed countries, would require substantial greenhouse gas emission reductions in participating developed countries, which would focus on all of these gasses listed in the previous table. Land-based activities would primarily focus on CO_2, CH_4, and N_2O.

2.1.4 Potential Climatic Changes

According to current available temperature data over the last 100 years, global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated.

For a given concentration of greenhouse gases, the resulting increase in the atmosphere’s heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate.

Some of the modeled, potential global impacts due to global warming:

- Sea levels raising by 15 centimeters by year 2050, 34 centimeters by 2100,
- Loss of coastal dry land due to rising ocean levels
- Loss of wetland, wildlife habitat,

- Increased coastal erosion, flooding,
- Increased salinity of rivers, bays and aquifers,
- Impact sewage disposal capabilities along coastal areas,
- Affect drinking water aquifers along coastal areas
- Increased precipitation and evaporation, altering existing local climates,
- Decline of freshwater quantities,
- Wetter winter, drier summers, increase frequency of intense rainstorms,
- Insufficient water for navigation; lower production of hydroelectric power; impaired recreational opportunities along rivers and lakes,
- Poor water quality; and decreased availability of water for agriculture, residential, and industrial uses.

Agriculture is expected to be affected by global climate changes, where yields of many crops are likely to be affected by changes in average temperatures and precipitation as well as by changes in climate variability and the frequency of droughts and floods (USEPA 1997). Climate change may also affect availability of irrigation water, the prevalence of pests, and soil erosion. Increased CO_2 levels may increase yields (the "CO_2 fertilization effect"). Most projected impacts in the agriculture sector involve considerable uncertainty; different assumptions generate very different results that range from net benefits to net losses for US agriculture.

2.1.5 Potential Climate Change in Idaho

Over the last century, the average temperature near Boise, Idaho, has increased nearly 1°F, and precipitation has increased by nearly 20% in many parts of the state, and has declined in other parts of the state by more than 10%. These past trends may or may not continue into the future but over the next century, Idaho's climate may experience additional changes. Some examples of potential changes to Idaho's climate include:

- A warmer climate could mean less snowfall, more winter rain, and a faster, earlier snowmelt, which could result in lower reservoirs and water supplies in the summer and fall,
- Additionally, without increases in precipitation, higher summer temperatures and increased evaporation also would contribute to lower stream flows and lake levels in the summer,
- Lower streamflows and runoff could reduce rates of groundwater recharge and exacerbate water supply problems
- Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation, however, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other users,
- Climate change could increase wheat yields by 9-18%, barley and hay could increase by 12%, and potato yields could fall by 18% under severe conditions where temperatures rise beyond the tolerance levels of the crop,
- If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture,
- Hotter, drier weather could increase the frequency and intensity of wildfires, threatening both property and forests,
- Although Idaho is in compliance with current ozone air quality standards, increased temperatures could make remaining in compliance more difficult
- If conditions become warmer and wetter, mosquito populations could increase, thus increasing the risk of transmission of this and other diseases are introduced into the area. Even in areas that generally are dry with a river water source, the mosquito populations may be expected to increase.

See the EPA report titled "Climate Change and Idaho", for additional information, found at http://yosemite.epa.gov/oar/globalwarming.nsf/content/Impacts.html

2.2 INTERNATIONAL, NATIONAL, AND STATE RESPONSES TO CLIMATE CHANGE

The scientific evidence seems to indicate that continuing emissions of greenhouse gases are altering global climate. In response, governments at the international and national levels are taking action to reduce emissions of greenhouse gases. Many individual countries and states have also recognized the potential dangers that global climate change presents to both current and future generations.

2.2.1 International Responses to Climate Change

The international community has coordinated efforts to address the potential impacts of climate change, particularly within the last decade. Some of the more important events are listed below:

- *Villach and Bellagio Workshops* - assessed the role of carbon dioxide…
- *The Montreal Protocol on Substances That Deplete the Ozone Layer* - 47 nations reached agreement on a set of CFC control measures in September 1987.
- *Toronto Conference* - focused on the implications of climate change for world security…
- *The Intergovernmental Panel on Climate Change* - was formed in 1988 to conduct studies on global warming.
- *The International Geosphere/Biosphere Program* - facilitate understanding the present state of the earth and the potential impacts of global climate change.
- *Noordwijk Conference on Atmospheric Pollution and Climate Change* - encouraged the IPCC to include in its First Assessment Report an analysis of quantitative targets to limit or reduce CO2 emissions, and urged all industrialized countries to investigate the feasibility of achieving such targets…
- *Hague Declaration* - This conference and Declaration (signed by 23 nations) established support for new principles of international law.
- *Cairo Compact* - calls on affluent nations to provide developing countries with the technical and financial assistance to address global climate change.
- *United Nations World Climate Conference:* The IPCC reported the findings of the IPCC Working Groups to the United Nations (Scientific Assessment, Impacts Assessment, and Response).
- *Intergovernmental Negotiating Committee (INC)* - the U.N. General Assembly established the INC to prepare an effective framework convention on climate change…
- *United Nations Conference on Environment and Development (UNCED)* - On June 12, 1992… signed the U.N. Framework Convention on Climate Change... commits the world's governments to voluntary reductions of greenhouse gases…
- *Bilateral Sustainable Development Accord Between Costa Rica and the U.S.* - the U.S. and Costa Rica signed a bilateral accord intended to facilitate developing joint implementation projects.
- *1995 First Conference of the Parties(COP)* - delegates agreed on a mandate to establish appropriate action for the period beyond the year 2000…
- *Ad hoc Group on the Berlin Mandate* - delegates to AGBM -1 began the process of drafting a protocol on new commitments for the post-2000 period.
- *1997 Third Conference of the Parties (COP-3)* - the parties agreed to an historic protocol to reduce global greenhouse gas emissions and set binding targets for developed nations – Initiated

the Kyoto Protocol.

- *IPCC 2001 Report.* This report concluded a firmer association with human activities and climate change. It reported a higher range of temperature increases over the next 100 years than what was previously reported.
- *COP-6 Bonn Germany*. Many issues presented by the U.S. in earlier COP meetings, were discussed and basically finalized. Mechanisms. Carbon sinks, Compliance, and Financing issues, which provided more flexibility to developed countries, such as the U.S. to fund developing countries projects and receive credit, allow for carbon sinks in forests and soils under practice initiated after 1990, with some stipulations. Operational details were to be finalized at COP-7.

2.2.2 National Responses to Climate Change

The United States has undertaken actions to address climate change, including scientific and economic research, policy analysis, and program development. Some of these actions are:

- *Climate Change Action Plan* (CCAP) by the Clinton Administration in October, 1993 . The CCAP presented the U.S. strategy for reducing greenhouse gas emissions to 1990 levels by the year 2000. The CCAP called for voluntary measures by industry, utilities and other large-scale energy users. CCAP stressed energy-efficiency upgrades through new building codes in residential and commercial sectors. Large-scale trees planting and forest reserves were encouraged to enhance sequestration of $C0_2$ and to conserve energy. The CCAP avoided mandatory command and control measures.
- The Bush administration has developed a U.S. Climate Change Research Initiative, and a National Climate Change Technology Initiative.
- In February of 2002, President Bush announced a U.S. Policy for climate change, a new approach for meeting the long-term challenge for climate change. The reduction of greenhouse gas intensity of the U.S. economy would be 18% over the next 10 years. Greenhouse gas intensity measures the ratio of greenhouse gas emissions to economic output, which has been declining over the past several years. The goal, to be met by voluntary action, was to reduce emissions the 183 metric tons per million dollars of GDP to 151 in 2012. If not on track by 2012, and sound science justifies further policy action, the U.S will respond with additional measures that may include a broad, market-based program and other incentives and voluntary measures to accelerate technology development.
- Funds for carbon related research and agricultural activities in the Farm Bill were proposed under H.R. 2646.
- S. 769 proposed the establishment of a carbon sequestration program, as well as S. 785.
- S. 1293 was presented to amend Internal Revenue Code to allow for incentives for voluntary reductions of emissions and sequestration activities.
- S. 1781 was proposed, which would require the Secretary of Commerce to establish a voluntary system for trading for industrial greenhouse gases. Other similar bills have been introduced in the U.S. Congress with much support for continued research.

2.2.3 Other State Responses to Climate Change

Many individual states and localities have also initiated independent climate change responses. At the state level, many have developed a state-level greenhouse gas inventory, and many have developed or committed to develop a state-level action plan to reduce greenhouse gas emissions. Some are listed below that may be applicable to Idaho:

- The Iowa State Energy Bureau's Building Energy Management Program promotes cost-effective energy management improvements in state buildings, schools, hospitals non-profit organizations, and local government facilities (Wells, 1991).

- In Minnesota, more stringent energy standards have been adopted for the new construction of residential dwellings and government offices.
- Oregon has increased the weatherization standards in the construction of low income homes.
- New York has recently established a public-private partnership to encourage and support schools in making their facilities more energy efficient (*Energy Smart Schools*).
- Colorado has established the *Colorado Green Program*, which assists builders and honors residents who construct homes that conserve natural resources and increase energy efficiency.
- Mecklenberg County, North Carolina all school buses have been converted to CNG vehicles.
- Maryland, the Department of Transportation has replaced its fleet of diesel fuel shuttle buses at BWI with 20 new CNG vehicles. Also, the governor signed an executive order which formally expressed Maryland State Government's commitment to improve air quality and to comply with the clean fuel provisions of the *Clean Air Act Amendments of 1990* (CAAA of 1990) and the Energy Policy Act of 1992 (EPAct).
- *The Georgia Governor's Office of Energy Resources* is increasing energy and agricultural efficiency by facilitating six programs targeted to crop, poultry, and livestock producers. These programs conserve energy and save money in addition to reducing greenhouse gas emissions.
- *The Missouri Department of Natural Resources* has created a reforestation program designed to reduce heating and cooling needs with strategic landscaping, to arrest soil erosion, enhance natural water filtration, and remove carbon dioxide from the atmosphere. The program coordinator of this multifaceted project, called Operation TREE, must work to involve every division of the Department of Resources and encourage cooperation among other state agencies (Wells, 1991).
- *The Alabama Broiler Litter Program*, co-sponsored by the Science, Technology and Energy Division of the Alabama Department of Economic and Community Affairs and the USDA's Tennessee Valley Resource Conservation and Development Council, addresses energy conservation, reduces the landfill waste stream, promotes recycling, and improves agricultural productivity. In this program newspaper is shredded and blown over the poultry house floor, where it becomes matted and slick from droppings and moisture content. When the litter and paper is gathered from the floor, it is spread on crops as fertilizer, or is mixed with feed and is fed to livestock. The paper also acts as an insulator for the poultry house, thereby reducing energy needs (*Conservation Update*, September 1994).

These state activities listed above demonstrate how Idaho can implement programs to address climate change and benefit the state. Because Idaho is more attuned to local public sentiment than are their federal counterparts, a state planning process can incorporate localized public input and priorities. Federal agencies, however, must craft programs that cover larger regions of the country. As a result, state and regional priorities may be overwhelmed by national interests during federal planning. By initiating its own programs, Idaho can make adjustments according to their own needs, allocate resources as they see appropriate, and complement other state policy goals in ways that the federal government may not consider.

2.2.4 Idaho Activities

Some activities related to climate change are already occurring in Idaho. Cropland and forestry research, carbon sequestration on agriculture and forest-lands, and negotiations between energy companies and farm organizations are attempting to offset emissions is or has occurred. Some of these activities are summarized below.

2.2.4.1 PACIFIC NORTHWEST DIRECT SEED ASSOCIATION AGREEMENT WITH ENTERGY

The Pacific Northwest Direct Seed Association (PNDSA) is a grower-based organization committed to increasing direct seed farming systems in the Pacific Northwest. The primary goal of PNDSA is to increase the number of direct seeded acres from over 650,000 to 1 million by 2005. Direct seed is a tillage system that reduces soil disturbance while planting a crop, rewarding farmers with less inputs and reducing field erosion significantly, improving multiple natural resource conditions. Carbon sequestration also occurs under a direct seed system, which PNDSA has been working with researchers on the estimate an amount of carbon stored over a period of time.

PNDSA has recently negotiated an agreement with Entergy, a company from the Southeast, which will lease 30,000 tons of CO2 offset credits from the organization, fulfilled through its membership. Bt agreement, credits are generated by growers who have agreed to use direct seed agriculture methods for at least 10 years; direct seed cultivation avoids soil losses from oxidation associated with using traditional tillage techniques, and also reduces the growers' fuel use and soil erosion.

PNDSA is the aggregator and administrator of each 10 year lease. The eligible members are those that have ground direct seeded before 2002 that will be direct seeded for the next ten years. Annual or perennial crop production is acceptable. The actual number of tons will be calculated when total number of acres used in the contract are known. Verification will occur with the best available technology. Entergy and PNDSA will jointly seek development of verification models useable by all growers and energy companies for the future.

2.2.4.2 NEZ PERCE TRIBE - TRAMWAY CARBON SEQUESTRATION AND CRP PROJECT

The Nez Perce Tribe - Tramway Carbon Sequestration Project will sequester atmospheric carbon dioxide (CO_2) by planting trees on non-stocked agricultural land in north central Idaho that otherwise would not naturally regenerate and would not otherwise be planted. Ponderosa Pine seedlings are to be planted on the site. The Nez Perce Tribe will grow crop trees for a minimum of 80 years and to engage in sound forest management practices that will aid in attaining the maximum potential growth of crop trees.

The Nez Perce Tribe must meet several criteria to ensure that the Tramway – Agricultural Conversion Carbon Sequestration Project does not plant trees that otherwise would have been planted using other funds. The project area has been cultivated for agricultural production on forest soils for approximately 70+ years. The site would not regenerate naturally and planting tree seedlings is the best option for establishing trees on the site. The total area to be planted is about 400 acres. Anticipated benefits derived from the above ground biomass of wood alone is estimated at 46,859 metric tons of carbon or 171,974 metric tons of CO_2 equivalents over the 80 year period. An additional 9,044 metric tons of carbon or 33,192 metric tons of CO_2 equivalents is anticipated to be sequestered on site as soil Carbon. The approximate total of all carbon anticipated to be sequestered on site is 55,903 metric tons of carbon or 205,165 metric tons of CO_2 equivalents over the 80 year period.

2.2.4.3 EXISTING AND PROPOSED ETHANOL PLANTS

There are currently two small fuel grade ethanol plants owned by the J.R. Simplot Company producing fuel grade ethanol from potato peel and chips. These plants having been producing ethanol since the mid-80's. There are other entities considering building several large modern ethanol plants in the near future. A proposed ethanol plant in Payette County has received funds from the USDA Value Added Agriculture Product Market Development Grant to help launch the plant (Idaho Statesmen, 10/25/02). Local farmers and business leaders have been contributing money for the plant. Local farmers would provide grain, enough to run the plant, to market the ethanol in Idaho and other Northwest states.

2.2.4.4 RESEARCH ACTIVITIES

Some agricultural related soils, carbon and related research activities have been ongoing by organizations such as the University of Idaho and the USDA Agricultural Research Service:

- The USDA Agricultural Research Service, Northwest Watershed Research Center (NWRC) began deployment and testing of Eddy Covariance instrumentation to monitor canopy-scale water and carbon flux at the watershed. These data will complement the existing hydrologic-data collection network and will add a carbon flux component to the research program. After a period of testing, and development of a telemetry and database management system for these instruments, they will also be used to collect data in collaboration with the ARS Rangeflux network. This network was established in 1996 to monitor CO2 flux over unmanaged native rangeland in 9 western states.

- The USDA Agricultural Research Service, of Kimberly Idaho (NWISRL) has looked at dissolved organic carbon from the soil rooting zone, where little or no published information is available describing drainage losses of dissolved carbon (DOC) from furrow-irrigated calcareous Portneuf silt loam to the vadose beneath. Studies have determined that there is an annual mass loss of from one field was 56.4 kg/ha/y, or about 0.1% of the organic carbon present in soil (0 to 120 cm).

- The USDA Agricultural Research Service, of Kimberly Idaho and the University of Idaho Research & Extension Center in Parma, Idaho is conducting studies on manure/compost application effects on sugar beet establishment, N uptake, yield, and quality, topsoil and subsoil chemical and physical properties. The purpose of the study is to determine the effect of manure and compost application rates on N uptake and sugarbeet production, soil nutrient status, organic matter and soil carbon /changes, and soil physical and structural properties.

- Studies at the University of Idaho include:
  Variation of Fragipan Depth, Above-Ground Biomass, and Soil Carbon in a Small Grass Watershed. The research objective was to develop relationships between subsurface morphology and C movement at the subwatershed scale. The study site is a 1.7-ha subwatershed located in the eastern Palouse region of northern Idaho. Biomass was measured at points throughout the watershed. Preliminary data indicate that fragipan characteristics may be the best predictor of C accumulation in the watershed. This data will be useful in refining C cycling models for use in areas where water restrictive horizons are present.

  Evaluation of soil properties and management on decomposition of a common wood substrate. The objective of this study is two-fold. The effects of various forest management practices (e.g. timber harvesting, site preparation, fertilization) are compared on the decomposition of wood stakes at nine sites located across the Inland Pacific Northwest region. The effects of soil moisture, texture, volcanic ash influence, temperature, O_2/CO_2 levels, and microbial biomass and functional diversity on wood decomposition rates are evaluated. It is hoped that this decomposition information will give an integrated assessment of soil type and forest management impacts on soil biological properties, and can ultimately be tied to soil productivity and sustainability on managed forest sites.

  Supercritical Fluid Conversion of Biomass into Chemicals and Fuels. The aim and rationale of this project is to utilize lignocellulose products to produce chemicals and liquid fuels by using a "supercritical fluid" (SCF) treatment. SCF (either water or methanol) conversion of biomass is a relatively recent technology that is capable of depolymerzing lignocellulose derived materials to monomers, yielding similar results as with acid hydrolysis, but without the drawbacks set forth by these technologies. The outcome of this project is to establish the viability of supercritical fluid processing of biomass to fuels and chemicals (biorefinery). In addition, develop a biobased-chemical economy from renewable resources.

Non-thermal Residue Management in Kentucky Bluegrass Seed Production Systems. The overall goal of this project is to determine the effectiveness and sustainability of non-thermal residue management practices to maintain this perennial crop that protects against soil erosion and therefore can improve water quality. Preliminary data from Lewis indicate that the yield improves (due to savings in soil moisture) enough to make up for the loss of a crop in the fallow year. Preliminary data on residue levels indicate that chemical suppression, along with mechanical treatment is relatively effective at reducing residue levels at the Lewis Co. site. Data indicates that the practices of bailing and burning may not be necessary in all Kentucky bluegrass seed production systems. The sustainability of non-thermal systems will likely depend on the variety planted and site-specific environmental conditions. Non-thermal management practices developed based on this research has the potential to lead to improved soil, water, and air quality, while providing an opportunity for growers to participate in developing C markets.

Metabolic engineering of Lactobacillus for ethanol production. The long-range goal is to generate the ideal microbial biocatalyst for lignocellulosic biomass-to-ethanol conversion. The objective of this research proposal, which is the next step toward attaining our long-range goal, is to metabolically engineer *L.* MONT4 for ethanol production.

Other U of I research include measurements of C levels in CRP, and conventional and no-till agricultural systems; use of remote sensing to track long-term and current land use changes in Idaho; quantification of organic matter decomposition in forested systems; nitrogen availability in manure and composted amended soils and determination of credits to inorganic N fertilizer application; quantification of soil organic matter under various types of urban plantings; improving the efficiency of ethanol production from agricultural products through the use of unique microorganisms; isolation and generation of microorganisms for use as "biocatalysts" in the conversion of off-grade potatoes and potato processing waste to lactic acid; viability and optimization of supercritical fluid processing of biomass to fuels and other value-added products; use of Brassica species as natural pesticides, organic fertilizers, and biodiesel production.

The University of Idaho Department of Biological and Agricultural Engineering has been investigating the feasibility of utilizing plant-derived oils as fuels in compression ignition engines. Demonstration projects have ranged from using raw unrefined oil as fuel to ASTM grade biodiesel powering an 18-wheeler with a 50:50 blend of biodiesel and No. 2 diesel for 200,000 miles.

2.2.5 Future State Action

While Idaho's emissions are low when compared to other states, it can adopt strategies to provide offsets through carbon sequestration and/or agricultural related emission reductions, for specific greenhouse gases elsewhere in the U.S. or anywhere in the world. These offsets would primarily come from carbon sequestration or reduced emissions from agricultural or forestry activities. While global warming is likely to be addressed through cooperative national and international efforts, many actions can be initiated locally. The state might find it wise to take action prior to national legislation, where regulations may not be beneficial to the state. There are some reasons that Idaho may wish to take definitive action to increase stored carbon and offset greenhouse gas emissions from other source around the world. One reason may simply be to increase the state's economy through carbon markets. Another reason is simply to utilize an effective means to reaching the state's own natural resource objectives. Many recommendations are presented in Chapter 9.