

# Environmental Education Module

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# Global Change

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## **PREFACE**

*Mankind today is in an unprecedented position. In the span of a single generation, the Earth's life sustaining environment is expected to change more rapidly than it has over any comparable period of human history. Much of this change will be of our own making. Worldwide economic and technological activities are contributing to rapid and potentially stressful changes in our global environment in ways that we are only now beginning to understand. The effects of these changes may profoundly impact generations to come.*

The International Geosphere-Biosphere Programme, 1990

This document focuses on global change, the issues associated with global change, and opportunities which are available to the educational community for dealing with these issues in the secondary school. It must be noted that global change is an extremely difficult topic with which to deal. It is composed of a multitude of human activities which contribute to it and a wide array of complex issues which are associated with it. These elements make it difficult to prepare a document which succinctly and clearly delineates global change, the underlying causes and issues, or the educational strategies which can adequately impact it. However, what appears here should serve as a beginning for the professional educator - an introduction to the content of global change, the associated issues, and educational opportunities for changing human behavior in positive ways.

Chapter I deals with the complexity of global change, an introduction to the substantive structure of environmental education, guidelines for the curriculum developer, and how global change fits into a school's curriculum.

Chapter II focuses on the content of global change. Content associated with global warming, deforestation, population, energy consumption, and land use management is presented. In addition, issue vignettes are presented as exemplars along with what is termed the fallacy of separatism, an important concept when dealing with global change.

Chapter III presents strategies for dealing with global change issue instruction. Responsible environmental behavior is discussed as well as research findings which impinge on the development of such behavior. Instructional approaches are described and compared.

Chapter IV deals with infusing global change instruction into the secondary school curriculum. Guidelines for educational planners are suggested and opportunities for infusion are charted in some detail. Courses incorporated include science, social studies, math, health, home economics, and agriculture.

The document ends with an extensive bibliography subdivided into sections designed to assist the educator in finding those resources he/she needs. The professional educator should find many of these references to be of enormous help in planning for instruction.

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## PART I

### Global Change and Environmental Education

*Today the scale of our interventions in nature is increasing and the physical effects of our decisions spill across national frontiers. . . . many regions face risks of irreversible damage to the human environment that threaten the basis for human progress.*

*Our Common Future, The World Commission on the Environment and Development, 1987.*

#### An Introduction

During the past generation, the earth's environment has changed more rapidly than at any other comparable time in history (International Geosphere-Biosphere Programme [IGBP], 1990). Although natural phenomena have played a part in this change, the primary source of these dynamics have been precipitated by human interaction with the biosphere. Those influences, whether produced inadvertently or purposefully, have created or will create dramatic global changes that may alter human existence for many years to come.

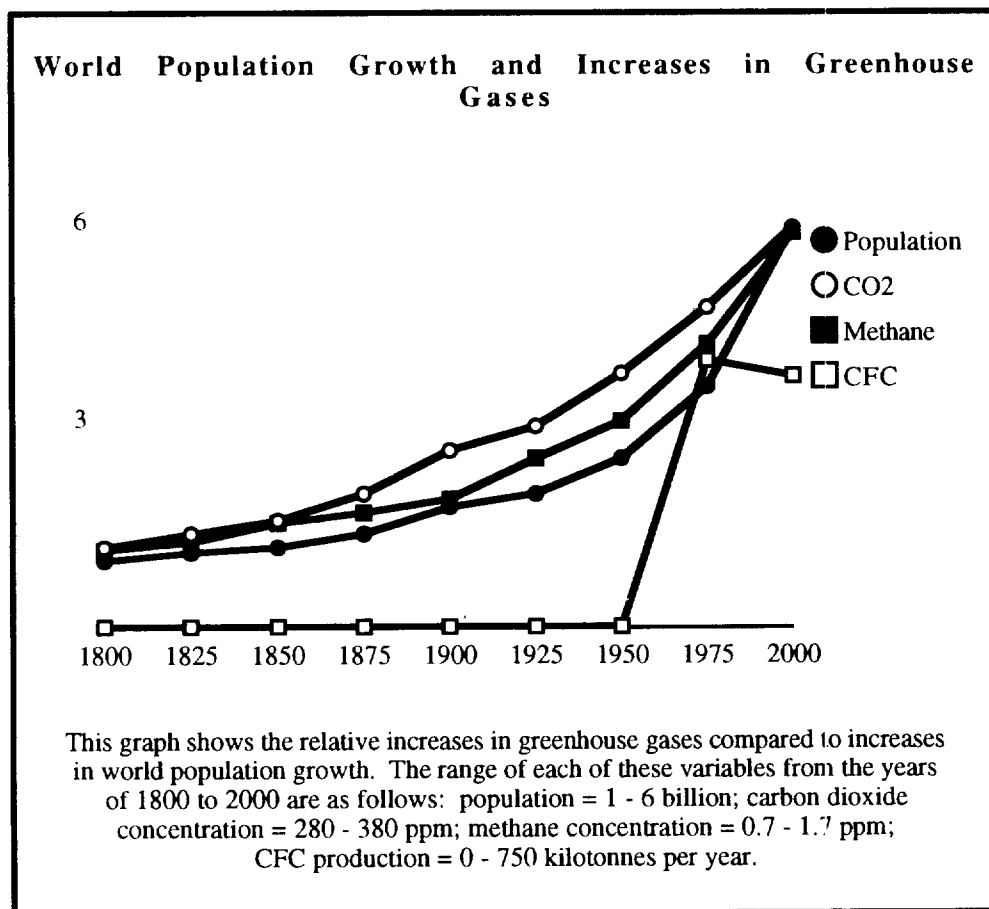
These global changes are outcomes of human beings' political, social, religious, and economic relationships with the earth. Agriculture, forestry, energy production and use, population increases, and other environmentally-related activities of the human organism have altered both terrestrial and aquatic ecosystems as well as the atmosphere of earth itself. These alterations include, among other things, global warming, ozone depletion, biological productivity, biodiversity, air quality, and quality of life for millions of human beings. All of these fundamental environmental changes transcend national boundaries and must be viewed on a global perspective.

**All of these fundamental environmental changes transcend national boundaries and must be viewed on a global perspective.**

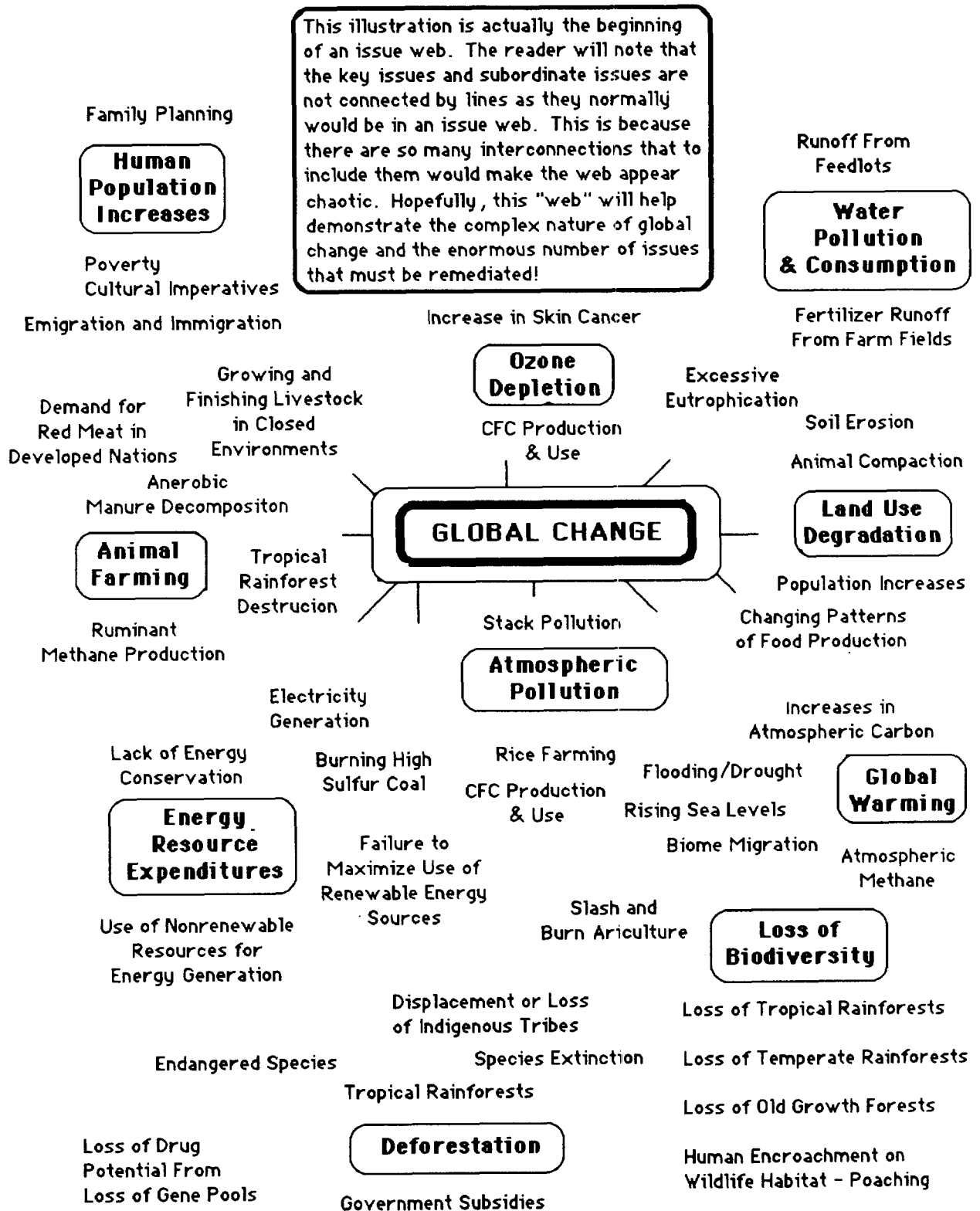
Any discussion of the key environmental issues involved in global change will probably be met with some controversy. Just what are the key issues involved in global change? If we can agree on the key issues, what, then are the subordinate issues? Perhaps it is not critically important, in a document such as this, to spend a great deal of time defending one particular perspective concerning a list of issues. Rather, it is probably far more important to look at the issues which are involved, or are probably involved, in global change. Those issues should be approached in a manner which results in producing educational outcomes related to changing human behavior. The direction of those behavior changes should be one which contributes to the resolution or partial resolution of global change issues.

How we look at global change issues is extremely important in an educational sense. The "issue web" found on the facing page displays what the writers refer to as "key issues" and "subordinate issues". This issue web is, in no way, complete! However, it does provide an opportunity to arbitrarily designate some issues as "key issues" and other topics as subordinate to them. Thus, it gives the observer an opportunity to view a large number of issues which are involved (or are thought to be involved) in global change.

It also gives the observer an opportunity to begin viewing this seeming multitude of issues in a manner that shows, at least to some extent, how interrelated they are. All of these issues are, in some way, related to each other. It would probably be impossible to impact on one without influencing the others to some degree. One small example of that rests with the correlations that exist between sharply increasing human populations and concomitant increases in methane, carbon dioxide, and CFC's. This correlation can be viewed in the graph that follows:



## GLOBAL CHANGE AND KEY ISSUES



Educationally, we are met, therefore, with something of an enigma. On one hand, we must help learners view global change holistically - to see the very real and crucial interrelationships that exist among a number of critically important issues. And, too, we

**On one hand, we must help learners view global change holistically . . .**

must make certain that learners understand the trans-boundary nature of these issues and their interrelationships. On the other hand, we must somehow look at issues in a discrete manner, allowing learners to critically analyze individual issues at the local and regional levels so that they may have some indepth understanding of how they impact, not only internationally, but locally

and regionally as well. In addition, we would propose that it is the responsibility of educators throughout the world to help learners acquire a sense of ownership and empowerment regarding these issues so that they are prompted to want to help remediate them and feel empowered to do so.

Another problem faces the educator in search of solutions to global change issues. This problem rests with the fact that the many changes produced by the present generation and previous generations as well have made it difficult to determine precisely what we

do know about these global changes and their consequences. Numerous frustrations face the individual or agency trying to clearly and honestly synthesize global change as a holistic entity. First of all, there are areas in which there simply are not enough data to make empirically valid decisions. Secondly, even where data sets exist, there are arguments over their accuracy as well as over their significance. Thirdly, the very nature of global changes has produced a variety of interpretations of the phenomena within the world community based on varying political, economic, religious, and social values. All in all, these things make it difficult, although not impossible, to grasp the overall nature of global change.

**On the other hand, we must look at [global change] issues in a discrete manner.**

It rests with the world's educational community to help learners understand these difficult concepts and to help them to acknowledge their responsibilities for helping resolve the issues related to these concepts. This will be a difficult task albeit not an impossible one.

This document simply cannot present all of the foundational information that bears on global change and the issues involved in global change. Nor can it deal with all of the cultural variables associated with the advent of global change nor the resolution of it. It will, however, present information which will help the reader understand global change and the issues involved. It will provide guidelines for incorporating global change instruction into existing curricula, and it will provide strategies for involving learners in global change issue instruction. It will also help the reader develop curricular materials which can be designed to maximize opportunities for changing learner behavior with respect to global change issues. With these thoughts in mind, we will review the origins of environmental education (EE), and its goals and objectives. Subsequently, the nature of global change issue instruction and its relation to environmental education will be examined.

## The Origins of Environmental Education

The Ultimate Aim of Environmental Education: to aid learners in developing into citizens who possess the knowledge, skills, and attitudes which enable and encourage them to engage in environmentally responsible behavior.

Adapted from Gary Harvey, 1977

In the 1970's the world community began to focus on a concerted effort to bring environmental education into world prominence through the auspices of the United Nations. In 1975 a questionnaire entitled, "Assessment of Resources for Environmental Education: Needs and Priorities for Member States" was distributed by the environmental section of UNESCO to 136 member nations. The aim of this research was to furnish specialists and decision makers in EE with valid information on which future action could be based, taking into consideration the many difficulties associated with such an educational thrust at both world and regional levels.

A major component of the UNESCO questionnaire dealt with trends in EE programs. Several rather significant findings were produced from this study. Among them were:

- 1) World educational programs are insufficient in number or in scope to make environmental education a national preoccupation. This insufficiency was particularly evident in developing nations.
- 2) There exists a persistent lack of truly interdisciplinary approaches for environmental education programs. Educational programs based on real problems and a functional logic aimed at their solution, have not been developed, in a general manner, in any of the countries studied.
- 3) A definite lack of concrete problem-solving approaches exists. This condition tends to isolate the environmental education program from the surrounding community, resulting in only limited efficiency.

Contributing to the persistent presence of problems, at a time of emerging interest in environmental education, was the sometimes silent and sometimes vocal debate surrounding the philosophical dimensions of environmental education. These various perspectives of what constituted environmental education led to a multitude of programs revolving around traditional conservation education, nature interpretation, outdoor education, outdoor recreation, and others. There appeared to be little agreement as to the substantive structure of environmental education.

During this period of indecision and confusion in EE, UNESCO in cooperation with the United Nations Environmental Programme (UNEP) established the UNESCO-UNEP International Environmental Education Programme (IEEP) which organized a number of regional conferences and seminars, each contributing to a philosophy and a body of knowledge concerning world needs and a perspective of environmental education. These meetings led, eventually, to one of the world's first Intergovernmental Conferences on Environmental Education, organized by UNESCO in cooperation with UNEP. The

conference was convened in Tbilisi, Georgia (USSR) in October of 1977 and was attended by 66 member nations.

The Tbilisi Conference resulted in the unanimous agreement concerning the important role of environmental education in the preservation and improvement of the world's environment. From this conference came a document, the Tbilisi Declaration, which recommended educational objectives, policies, and strategies to be followed world-wide.

Current environmental education curricular programmes throughout the world reflect wide variations. Many of these programmes are consistent with the objectives presented in the Tbilisi Recommendations. However, some curricular efforts deal primarily with ecological principles, and others go beyond ecology to attempt to show the relationships existing between ecological concepts and environmental issues. A few attempt to deal with the skills and knowledge associated with the investigation, evaluation and remediation of issues. Few common threads appear which allow one to synthesize a model one could call, "current environmental education curricula". Diversity seems to be the major characteristic one observes.

Since the early 1980's there has been a set of goals and objectives for environmental education which has seen increasing use throughout much of the world and in a number of UNESCO documents. These goals were first defined in a document developed by Hungerford, Peyton, and Wilke and published in 1980. This document was written to be consistent with the categories of objectives included in the Tbilisi Conference Report. These are the goals and objectives that will be used here to establish the substantive structure for environmental education.

The goals and objectives for environmental education encompass four levels of knowledge and skills: 1) ecological foundations; 2) issue awareness; 3) issue investigation and evaluation; and 4) issue resolution. The first two goal levels focus on a conceptual awareness of ecological principles and environmental issues. Latter levels include objectives which deal with the development and application of skills prerequisite to investigating and evaluating environmental issues, and of participating in the solution of those issues.

## **Goals for Curriculum Development in Environmental Education**

### **Goal Level I - Ecological Foundations**

Upon completion of instruction in environmental education, the learner should be expected to be able to . . .

1. . . . communicate and apply the major ecological concepts including those focusing on individuals, species populations, communities, ecosystems, biogeochemical cycles, energy production and transfer, interdependence, niche, adaptation, succession, homeostasis, and man as an ecological variable.
2. . . . apply a knowledge of ecological concepts to the analysis of environmental issues and identify important ecological principles involved.
3. . . . apply a knowledge of ecological concepts in predicting the ecological consequences of alternative solutions to environmental problems.

4. . . . understand the principles of ecology in order to identify, select and utilize appropriate sources of scientific information in a continuing effort to investigate, evaluate and find solutions for environmental issues.

### **Goal Level II - Issue Awareness**

5. . . . understand and communicate how man's cultural activities (e.g., religious, economic, political, social and others) influence the environment from an ecological perspective.

6. . . . understand and communicate how an individual's behaviors impact on the environment from an ecological perspective.

7. . . . identify a wide variety of local, regional, national and international environmental issues and the ecological implications of these issues.

8. . . . identify and communicate the viable alternative solutions available for remediating crucial environmental issues as well as the ecological and cultural implications of these various solutions.

The most important fact molding our lives today is that over the past hundred years we have "gone around the bend" of four curves shaped like the letter J, which represent global increases in population, resource use, pollution of air and water, and environmental degradation of the soil, grasslands, forests, and wildlife populations that form the base of all human economic activity and growth.

G. Tyler Miller, 1988

9. . . . understand the need for environmental issue investigation and evaluation as prerequisite to sound decision making.

10. . . . understand the roles played by differing human beliefs and values in environmental issues and the need for personal values clarification as an important part of environmental decision making.

11. . . . understand the need for responsible citizenship action in the solution of environmental issues.

### **Goal Level III - Issue Investigation and Evaluation**

12. . . . apply the knowledge and skills needed to identify and investigate issues (using both primary and secondary sources of information) and synthesize the data gathered.

13. . . . demonstrate the ability to analyze environmental issues and the associated value perspectives with respect to their ecological and cultural implications.

14. . . . demonstrate the ability to identify alternative solutions for important issues and the value perspectives associated with these solutions.

15. . . . demonstrate the ability to evaluate alternative solutions and associated value perspectives for important issues with respect to their ecological and cultural implications.



16. . . . demonstrate the ability to identify and clarify personal value positions related to important environmental issues and their associated solutions.

17. . . . demonstrate the ability to evaluate, clarify, and change value positions in light of new information.

#### **Goal Level IV - Issue Resolution Skills**

18. . . . demonstrate a competence with a variety of citizenship action skills from the following categories of skills: persuasion, consumerism, political action, legal action, and ecomanagement.

19. . . . evaluate selected actions in light of their ecological and cultural implications.

20. . . . demonstrate the ability to apply one or more citizenship action skills for the purpose of resolving or helping to resolve one or more environmental issues.

#### **The Fallacy of Separatism**

*In the last half of the 20th century, environmental problems expanded from local to global prominence. . . . Problems such as global warming, ozone depletion and acid precipitation have conspired to form a planetary crisis. The indications for change are obvious, and the imperative for educators to respond is powerful.*

*Roger Bybee, 1991*

"Global Change" is a dramatic and potent reality for human beings and for the planet on which they live. And yet, it is a difficult entity to conceptualize, mainly because global change is not a problem easily defined nor is it a single issue. It is, instead, an amalgam of a number of issues! In order for global change to be conceptualized on some meaningful level, it must be synthesized, at some point, holistically. How easy will it be to do this? As noted above, we don't even know the extent to which our rapidly changing economic and technological activities will impact on the global environment. We can only rest assured that they will!

Earlier in Part I we noted that a discussion of key environmental issues involved in global change would probably be met with some controversy. Why? Because even informed, literate human beings would probably argue to some extent about an exact listing of the key issues involved in global change. And yet, we definitely tend to deal with global change issues on an issue specific basis, i.e., we inspect ozone depletion, greenhouse warming, population increases, land use management, energy production, etc. on their own merit with little thought being given to the synergism that exists between them. Why do we do this? We do this because the overall dynamics of global change are so very complex and the number of issues involved so numerous.

It is certainly a difficult task to realize that a cattle rancher in Colorado, and a rice farmer in Thailand, and a real estate developer in South Carolina, and a slash and burn farmer in South America, and an auto worker in Japan, and a young mother in Canada are far more closely environmentally related to each other than anyone realized just a short time

ago. Each one of these people is a "player" in one or more environmental issues regardless of the relative impact each has on global change.

No other aspect of global change symbolizes its holistic nature than does the threat of climatic change. The enormous and astonishing variety of activities that generate greenhouse gases: wood fires, animal farming, rice growing, power generation, air travel, grass and leaf burning, automobile travel, and others, are activities important one way or another to every human being on earth.

In an educational sense, how we look at global change issues is very important. We realize that it is difficult, if not impossible in secondary education, to discontinue looking at global change issues as separate entities. The "issue web" presented earlier displays what the writers refer to as "key issues" and "subordinate issues" related to global change. The issue web is, in no way, complete! However, it does provide an opportunity to arbitrarily designate some issues as "key issues" and other topics as subordinate to them. Thus, it gives the observer an opportunity to view a large number of issues which are involved (or are thought to be involved) in global change. It also gives the observer an opportunity to begin viewing this multitude of issues in a manner that shows, at least to some extent, how interrelated they are.

And, it is this interrelatedness that brings the "fallacy of separatism" to the surface! The key idea with the fallacy of separatism is simply that humans must begin to look at global change in a holistic manner, realizing the interrelatedness of the issues involved regardless of how difficult this may seem.

Educating about environmental issues, whether it be local, regional, or even global, is to a great extent a peripheral aspect of a school's curriculum. If and when environmental issues or problems are taught, students tend to *learn about* them rather than to *analyze and evaluate them thoroughly*. And, too, instruction on issues often denies the global implications of local issues or the local implications of global issues.

The concept that when a salesman from Vancouver, Canada gets in his automobile and drives to work he is potentially affecting a farmer on the central plains of China is somewhat abstract to say the least. Or that a woman in Nigeria - collecting and burning wood for cooking and warmth - can actually impact the fisherman who lives in Portugal is a baffling and, in a sense perhaps, an unbelievable thought. Or the same for a ship yard worker in Poland and a secondary school teacher in New Zealand. It is conceivable that, if we look at these scenarios strictly on an individual basis, these interactions may not, in fact, produce any appreciable impact. But multiply these actions several billion times in one form or another and it is almost certain that each one of us is impacting every world citizen, and the biosphere as well. It appears that this is one of the concepts that must be attained by everyone in the world community if global change issues are to be resolved.

*The adage, "Act locally, think globally!" has been viewed as a battle cry, of sorts, to environmentalists for nearly a decade. Unfortunately, the use of this perspective in the curriculum is as dim as the the fading bumper stickers that carry this message.*

*D. Knapp, 1991*

## PART II

### Global Change: Information and Issues

*Our planet and the global environment are witnessing the most profound changes in the brief history of the human species. Human activity is the major agent for those changes - depletion of stratospheric ozone, the threat of global warming, deforestation, acid precipitation, the extinction of species, and others that have not yet become apparent.*

*The roots of global environmental change are embedded in the advances over the past few centuries in the understanding of the natural world and the utilization of natural resources. These scientific and technological advances have produced the driving forces of global change.*

*National Research Council, 1989*

Scientists are aware that major changes on earth have taken place since the beginning of life. However, it has not been until quite recently (within the past 40 years) that experts have realized the possibility of rapid and large scale alterations to the biosphere. These potential changes and the effect these changes could have on the earth have precipitated a floodgate of new scientific information. Researchers on a worldwide basis have analyzed the potential causes for (and attempted to predict the impact of) these changes.

The overwhelming amount of data related to global change can itself be a problem in undertaking global change instruction. Theories and hypotheses for causes and effects of global change create a range of debates that leave the lay-person reeling in confusion. Therefore, a goal of the writers in Part II is to supply the educator with understandable and current information on global change.

Part II will first address five important global change issues: Global Warming, Tropical Deforestation, Human Population Growth, Energy Resource Consumption, and World Land Use. Each of these global change issues will be analyzed in terms of how and why that issue exists. Scientific information which is foundational to understanding each issue will be discussed, as will the the role of human activities in stimulating specific global changes. Subsequently, the impacts that these global changes could have on society and the biosphere will be explored. Each analysis will also address both the possible solutions and the barriers to those solutions. At the conclusion of each analysis, a brief vignette will focus attention on a regional or local application related to that particular global change issue.

**Global Warming  
World Land Use  
Tropical Deforestation  
Human Population Growth  
Energy Resource Consumption**

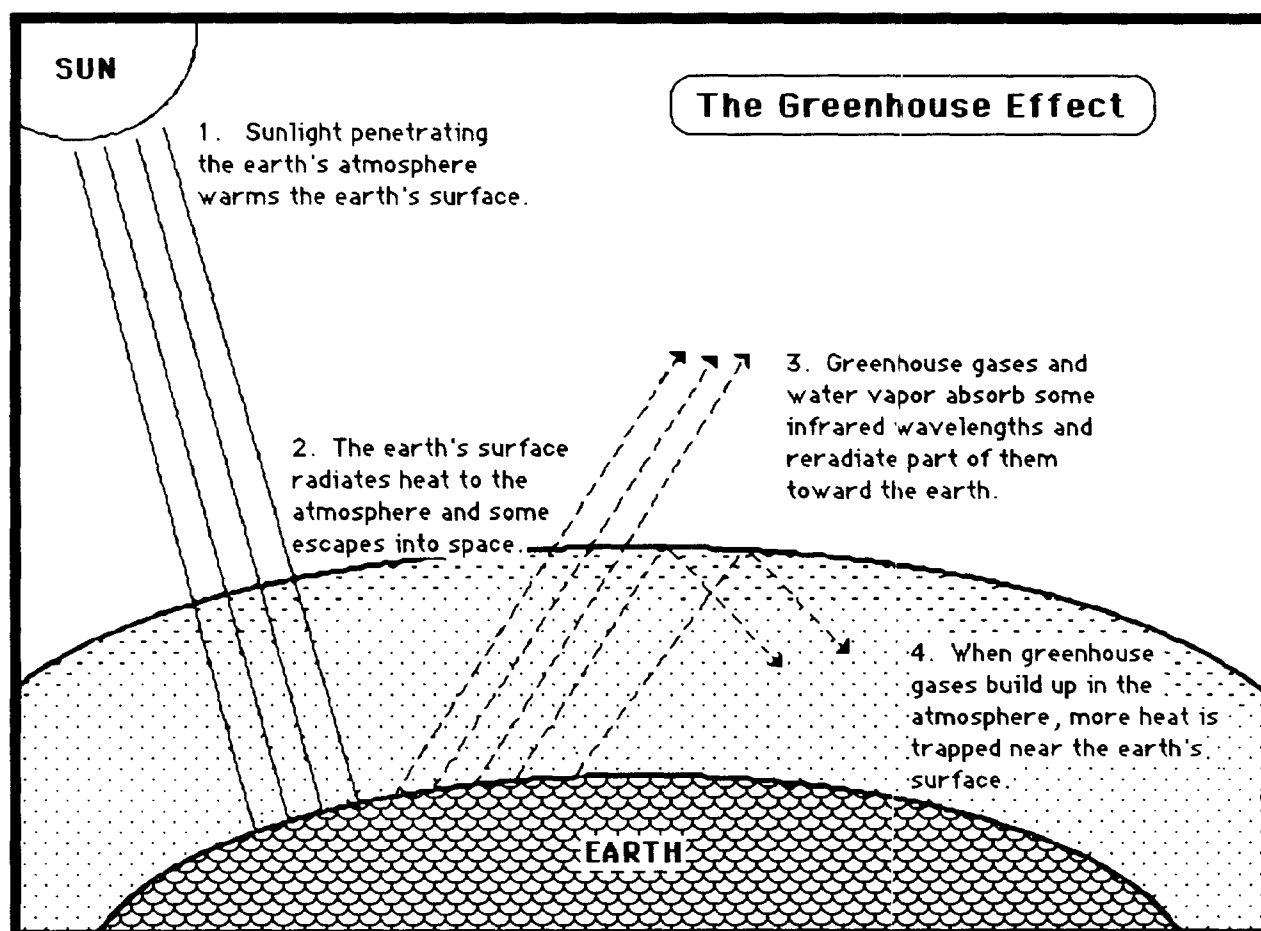
## Global Warming

*"Global Warming is an environmental threat unlike any the world has faced. While human activities during the past century have damaged a long list of natural systems, most of these problems are local or regional in scope and can be reversed in years or decades if sufficient effort is exerted. Changes to the earth's atmosphere, on the other hand, are global and - for all practical purposes - irreversible not only in our lifetimes but in our children's and grandchildren's as well."*

*Christopher Flavin, Worldwatch Institute, 1989*

An assumption that is often made about climatic change is that it is most closely associated with the previous century. Actually, global warming and other global changes have probably existed since life began on earth. The earth's biosphere has been changing continually over the eons due to natural processes.

Between 6,000 and 18,000 years ago - following the last ice age - a gradual warming of approximately five degrees Celsius (5°C) occurred (IGBP, 1990). This climatic modification influenced other global changes, such as the movement of whole biomes. One example of this can be seen in the land mass now known as North America, predomi-



inantly a coniferous forest biome before this warming. Today, these forests are located mostly in central and southern Canada.

Even though scientists have reported ongoing, naturally-occurring long term climate changes, it appears as though those changes may be accelerating. Recent and dramatic scientific data suggest the probability of as much as a three degree Celsius (3°C) warming trend over the next century (Flavin, 1989). Three degrees Celsius over a 100 year time span is rather startling compared to the change of five degrees Celsius over the previous 12,000 years.

Many scientists believe that this dramatic warming trend results from changes in the earth's "greenhouse gases". The greenhouse gases comprise a thin blanket of gases that has existed in the earth's atmosphere for as long as there has been life on the planet. This layer of carbon dioxide, ozone, nitrous oxide, methane, and water vapor allows solar radiation to penetrate the earth's atmosphere, reaching the earth surface. At the surface, much of this energy is absorbed, helping to warm the planet. Subsequently, radiant energy rises from the surface. Although some of the radiant energy escaped into space in the form of heat, much of it is absorbed by the gaseous layer and redirected back to the earth's surface, creating a further warming effect. This process is very similar to the way in which a greenhouse allows sunlight inside its structure and traps much of the energy to create a warm environment. Because of this, scientists refer to this phenomenon as the "green-house effect", and to the gases involved as "greenhouse gases".

### Major Greenhouse Gases

**Carbon dioxide.** This gas comprises the greatest share of the greenhouse gases. Major sources of this gas are the burning of fossil fuels (80%) and deforestation (20%).

**Chloroflourocarbons (CFCs).** It is predicted that by the year 2020, CFCs will comprise 25% of the greenhouses gases attributable to human activity. CFCs are used as refrigerant gases in air conditioners and refrigerators, as aerosol propellants, and in the production of plastic foams.

**Methane.** One-third of the methane in the atmosphere is produced naturally (e.g. emissions from bogs and marshes); the other two-thirds are by-products of rice farming, livestock management, deforestation, and human waste.

**Nitrous Oxide.** This gas is released through the breakdown of nitrogen fertilizers and as a by-product of internal combustion engines and burning fossil fuels.

### The Role of the Oceans in Climate Change

The oceans cover approximately 70 percent (70%) of the earth. As might be expected, there exists a critical relationship between this large biome and the biosphere. It is not surprising, therefore, to learn that the oceans are thought to play a significant role in climatic change

The oceans might be viewed as a means to temper large shifts in atmospheric temperature by their capacity to absorb greenhouse gases, in particular, carbon dioxide. Simply stated, the oceans act as a carbon "sink" by absorbing significant amounts of carbon dioxide. It appears that the oceans play a key role in the removal of carbon dioxide from the atmosphere, thus preventing (or slowing) the further build up of this gas in the atmosphere. Thus, the oceans might be viewed as a "buffer", a mediating influence on the amount of carbon dioxide in the atmosphere, and on related changes in atmospheric temperature. However, as water temperatures increase, gases (including carbon dioxide), are

"The oceans play a key role in determining the earth's climate. Any possibility of predicting the evolution of climate beyond a few weeks demands that ocean behavior be taken into account"

Intergovernmental Oceanographic  
Commission, 1991

released from the oceans. A number of scientists believe that a rise in temperatures due to global warming would likely decrease the capacity of the oceans to absorb carbon dioxide from the atmosphere (UNESCO Intergovernmental Oceanographic Commission, 1991).

Just as the oceans influence other biospheric variables, so too are they affected by those variables, among them climate.

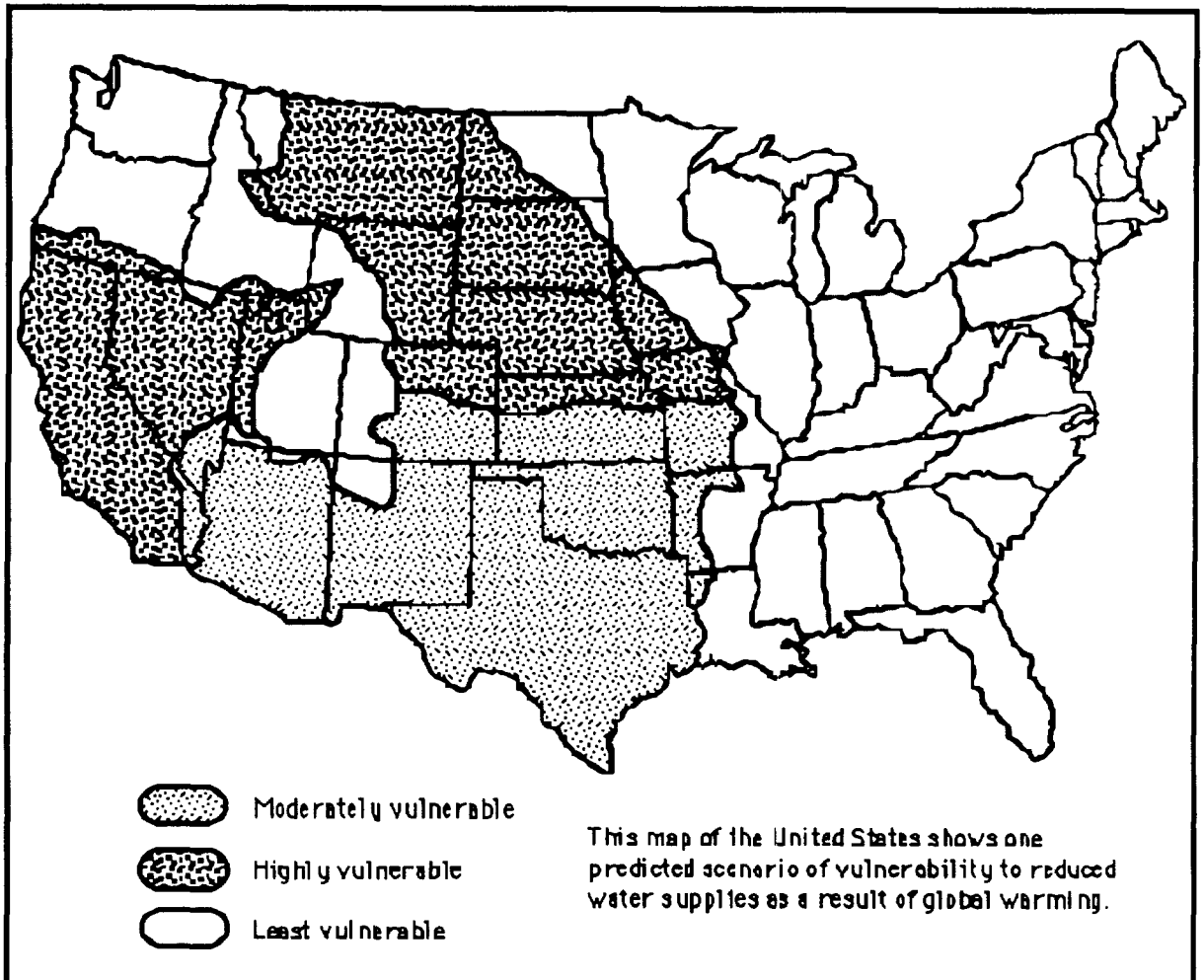
The Intergovernmental Oceanographic Commission (IOC) confirms this relationship, "There is every reason to believe that the ocean is now changing in response to climate changes over the past few hundred years" (1991, Annex III). The IOC believes that climate change will have an impact on the oceanic systems. This may, in turn, affect fisheries, coastal zones, fresh water sources and human settlements. An important caveat to these predictions is the lack of consensus as to the cause of the climatic change. For example, the IOC has questions in regards to the influence of carbon emissions from human activities. They believe that the amount of carbon produced by man is not as critical as that from other natural sources. As the IOC explains, "The fossil fuel CO<sub>2</sub> increment which has entered the ocean is a modest addition to that present from the natural carbon cycle" (IOC, 1991, p.25).

### **Impacts of Global Warming**

In May of 1989 the National Research Council of the United States predicted that several climatic changes would occur, if the increase of the greenhouse gases were to continue. Among those predicted climatic changes were: an increase in average surface temperatures; an increase in precipitation; a reduction of sea ice; an increase of continental dryness during summers; a rise in the sea levels; regional vegetation changes; and an increase in the occurrence of tropical storms. The following question seems pertinent: If these climatic changes take place within a relatively short period of time (within the next two or three centuries) what might the consequences be for both the biosphere and for human existence?

**Impact on Terrestrial Ecosystems.** Climatic changes will most certainly effect terrestrial ecosystems. It is expected that there would be increased demands on the carbon storage capacities of plants due to the increases in atmospheric carbon dioxide. Additionally, it is likely that the water-use efficiency of plants would be altered, decreasing evapotranspiration and thereby reducing regional and global cloud cover patterns. Because of the vulnerability of plants to these changes, global warming would pose its greatest threat to forest ecosystems. The rapid climate change anticipated by scientists would see forest biomes replace tundra in the northern hemisphere. Scientists predict that, due to the rapidity of the changes, many of these forests would not be able to "migrate" in time and massive amounts of vegetation could be destroyed. Although tropical forests may actually increase in range, temperate species such as beech and maple may become extinct (National Research Council [NRC], 1989).

**Impact on Food Production.** Warmer global temperatures would effect the human community in different ways. The projected changes of temperatures will be more significant in the the middle latitudes where two of the major food producing regions are located. Both the North American agricultural heartland and the central Asian plains will likely experience a decline in soil moisture as well as higher temperatures and more evapo-



ration. A study conducted by U.S. scientists suggests that the cropping area of the of the Great Plains could decline by as much as a third (NRC, 1989).

While declines in the middle latitudes would be evident, there is some speculation that other areas of the world may benefit from this global change. It is possible that agricultural opportunities in Canada, the Soviet Union, Africa, and the Ukraine could increase due to the warmer temperatures. These predictions are tempered by the fact that many of these regions do not have the soil nutrient capability to sustain that growth.

**Changes in Sea Levels.** Ambiguity also exists in relation to the potential for changes in sea level due to global warming. Many postulate that the increase of global temperatures could result in the rise of mean ocean depths. This, in turn, could cause a series of problems: the destruction of sensitive coral reefs, the flooding of ecologically important coastal wetlands, and the inundation of islands and low lying ecosystems.

However, others are not as comfortable with this scenario and are more cautious in their overall predictions of sea level change. The IOC reports that global sea-levels have risen by the order of 15 cm in the past 100 years. They believe that these sea level changes

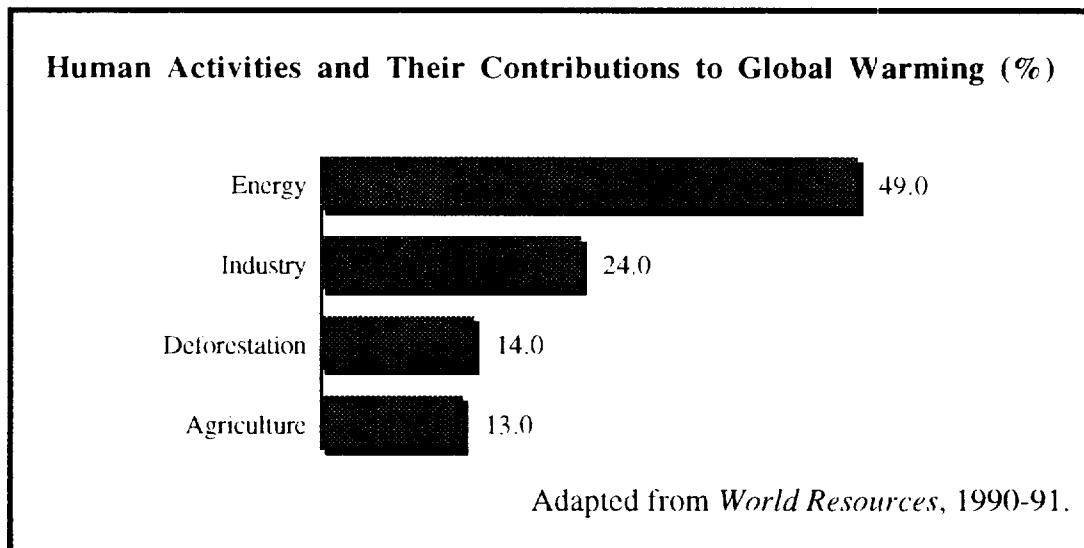
are strongly affected by land movements and local oceanography and meteorology. Despite this information they conclude that,

"[I]n many parts of the world, relative mean sea level is falling rather than rising, and may continue to do so despite greenhouse warming. Thus, one should speak of sea level change rather than sea level rise. . . . Changes in relative mean sea level differ substantially from place to place and from region to region." (IOC, 1991, p.26)

Despite the discrepancy in these hypotheses, a forecasted one to two meter rise in the oceans of the world would have a devastating impact on societies, both structurally and economically. A modest one meter rise would flood the low lying areas of major cities such as Shanghai, Cairo, Bangkok, and Venice. Large areas of rice producing lowlands and the deltas of Bangladesh, India, Egypt, and China would be flooded. Scientists predict that Egypt could lose 15 percent of its arable land along the Nile delta, displacing a seventh of that country's population. The loss of land mass could lower Egypt's GNP by as much as 14 % (NRC, 1989). Many wetlands that nourish the world's fisheries would also be destroyed.

### Societal Causes of Global Warming

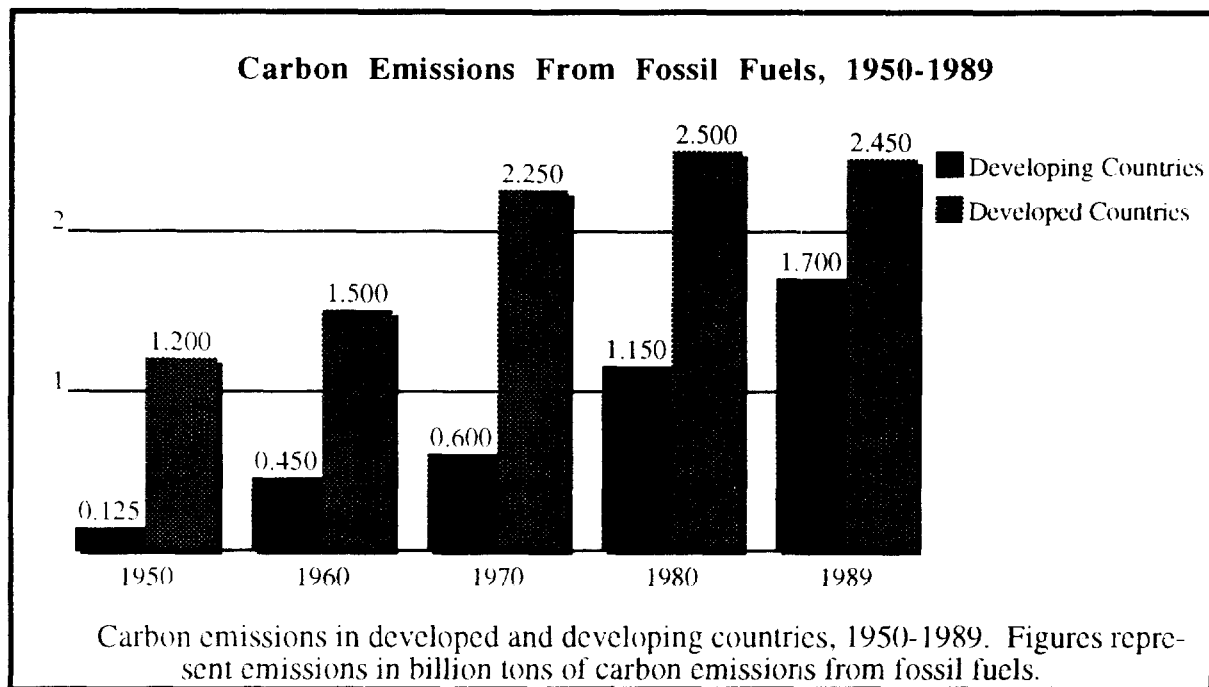
Global climatic change has occurred since life on earth began. Its causes, through the millennium, have been a complex series of biotic and abiotic variables. It appears that the recent acceleration in warming is heavily influenced by human activity, specifically, those activities which contribute to the increase in greenhouse gases.



**Increases in Carbon.** Carbon has become one of the largest waste products of modern industrial civilization. Carbon dioxide accounts for fifty percent of the human-caused input into the greenhouse gases (Miller, 1991). The two primary sources of this carbon are deforestation and the combustion of fossil fuels. Since the industrial revolution, these two activities have led to a 26% increase in carbon dioxide concentration in the atmosphere (World Meteorological Organization / United Nations Environment Program [WMO/UNEP], 1990). For example, during 1988, 5.66 billion tons of carbon were pro-



duced by the combustion of fossil fuels, more than a ton for each human being on earth (Flavin, 1989).

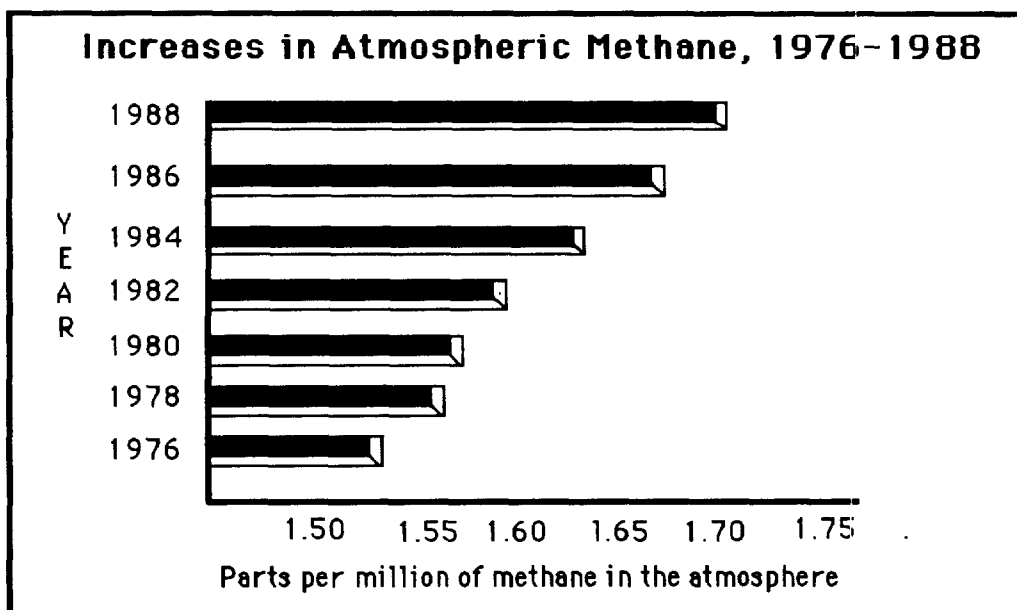
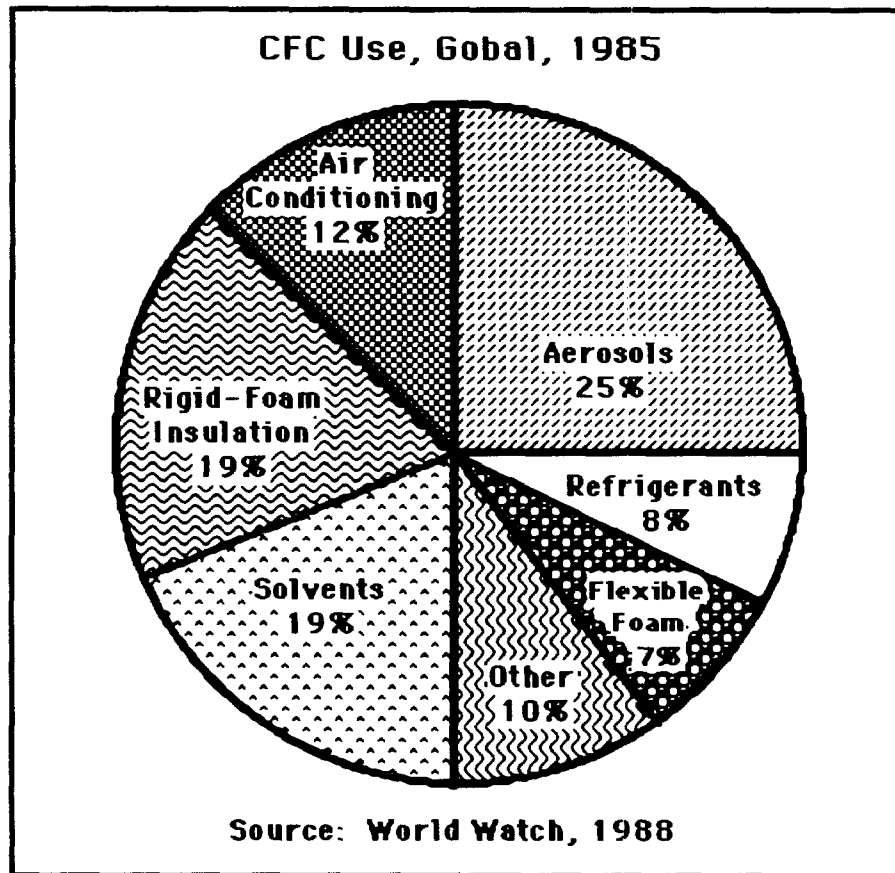


Each ton of carbon emitted into the air results in 3.7 billion tons of carbon dioxide. Although the effects of these emissions are experienced worldwide, there is a disparity between the developed and underdeveloped countries in per capita production of carbon. In fact, only one-fourth of the world population accounts for seventy percent of the world's carbon emissions (Flavin, 1989). It must be noted, however, that third world countries account for the majority of carbon emissions from deforestation. Brazil, for example, contributes an estimated 336 million tons of carbon to the atmosphere a year due to the cutting and burning of tropical rainforests.

**Increases in Chloroflourocarbons.** Although carbon dioxide accounts for the greatest amount of greenhouse gases emitted by humans, it certainly isn't the only important waste product influencing the climate. Chloroflourocarbons or CFCs make up 14% of the human-made greenhouse gases. CFCs are man made chemicals used in industrial processes and consumer products. The average refrigerator, home air conditioner, and automobile air conditioner contains two to three pounds of CFC's in the form of a gaseous refrigerant. When this substance is drained from those devices, emissions leak into the atmosphere. Certain packaging, insulation, and aerosol sprays also contain CFCs and leak into the air when used or disturbed. This gas is actually a stronger "blocking" agent than carbon dioxide. CFCs can remain in the atmosphere for 65 to 111 years and have 10,000 to 20,000 times the impact per molecule as that of carbon dioxide (Miller, 1991).

CFCs are also blamed for depleting the ozone layer. While ground level ozone concentrations can be harmful, atmospheric ozone concentrations block harmful ultraviolet radiation from the sun and protect humans from skin cancer.

It appears that CFC's destroy atmospheric ozone compounds. One 1988 study indicated that ozone layers have declined two percent worldwide since 1969 (Global Tomorrow Coalition [GTC], 1990).



Over 140 million tons of methane are being released annually, mainly due to increases in livestock production and deforestation.

**Increases in Methane.** A third gas, methane, accounts for 18% of the greenhouse gases. Methane levels remained fairly constant until the industrial revolution. Since that period, however, the amount of this gas in the atmosphere has nearly doubled. Today, over 140 million tons of methane are being released into the air annually (Rifkin, 1991). Scientists believe that this increase is related to the human activities of cattle farming and deforestation. Livestock account for the greatest rise in methane concentrations. Each cow, through digestion and excretion emits an average of 400 liters of methane into the atmosphere every 24 hours (Rifkin, 1991). Today, over 1.2 billion cows are being grazed in countries around the world contributing to an annual release of 54.3 million tons of methane.

Due to the rapid rate of deforestation, a massive increase in termite populations has been recorded. It has been found that the decomposition of wood in the termite gut emits methane. Thus the increase in deforestation has allowed the termite population to flourish and indirectly contributes to the increase of methane in the atmosphere.

**Increases in Nitrous Oxide.** The final major greenhouse gas is nitrous oxide. This gas is released through the application of petrochemical fertilizers. During the past 40 years, the use of petrochemical fertilizers has increased by an average of 121 tons a year (Rifkin, 1991). Nitrous oxide is also produced through the burning of fossil fuels.

### Reducing the Greenhouse Gases

The contribution to the greenhouse gases by humans and the possible climatic changes resulting from these emissions is probably the most serious global change facing the world community. As stated above, the primary cause of global warming is the emission of carbon dioxide, CFCs, methane, and nitrous oxide into the atmosphere. Therefore, it is highly recommended that emissions from each of these gases be reduced.

<b>Annual Emissions of Carbon Dioxide, Methane and CFC's</b>				
<u>Country</u>	<u>Carbon Dioxide</u>	<u>Methane</u>	<u>CFC's</u>	<u>Total</u>
	(Amounts In Metric Tons)			
United States	540,000	130,000	350,000	1,000,000
USSR	450,000	60,000	180,000	690,000
Brazil	560,000	28,000	16,000	610,000
China	260,000	90,000	32,000	380,000
India	130,000	98,000	700	230,000
Japan	110,000	12,000	100,000	220,000
Germany	79,000	8,000	75,000	160,000
United Kingdom	69,000	14,000	71,000	150,000
Indonesia	110,000	19,000	9,500	140,000
France	41,000	13,000	69,000	120,000

**World Resource Institute [WRI], 1990, p.15)**

**Carbon Dioxide.** There are two major ways to reduce the carbon element in the use of fossil fuels. The first method is improving energy efficiency. Currently, 64% of the world's electricity is produced through fossil fuels. Studies have shown that the use of electricity can be reduced by redesigning machinery and other electrical powered equipment used in the generation of energy. Methods of transportation could also be altered. The world's 400 million cars emit about 550 million tons of carbon annually into the air. Declines in these emissions can and are beginning to be obtained by producing fuel efficient automobiles, as well as by turning to cleaner fuels such as ethanol.

... scientists in the United States and Great Britain dropped a grenade into the global warming debate when they simultaneously released data showing that 1990 had been the warmest year ever recorded. ... Any given year has the potential to be the hottest, but scientists point to a more disquieting fact: The dubious 1990 record comes after a string of extraordinarily warm years. Globally, since 1980, the world has suffered six of the seven warmest years on record.

Jon R. Luoma, in *Audubon*, March 1991

The second means to reduce carbon is to develop alternative energy sources. Nuclear energy has long been viewed as a new and "cleaner" energy source. But due to poorly designed and regulated management systems as well as the societal concern for safety, this option, at present, is at a standstill. In fact, as of 1989 just 94 nuclear plants were under construction worldwide (Flavin, 1989). Other sources of alternative energy include wind, solar, thermal, and biomass energy. Since the late 1980's the use of wind as an energy source has seen an upsurge. By 1989 there were over 20,000 electricity-producing wind machines in use. This number of machines would have the capacity to power the homes of San Francisco annually (Flavin, 1989). Although this represents a comparatively small proportion of the world's energy needs, its economic feasibility makes it a hopeful alternative for the future. With an annual production of over 5,000 megawatts around the world, geothermal is another growing alternative energy source. In some areas of the world, geothermal use is likely to double by the year 2000.

As with geothermal and wind, the use of solar energy worldwide is at best in its infant stages. The Solar Energy Research Institute, however, has estimated that this form of energy is capable of producing half of the United States' electricity within four to five decades. The Institute is also hopeful of meeting much of Europe's energy needs with a plan to obtain its solar power in North Africa (Flavin, 1989).

**Chloroflourocarbons.** The international community is attempting to ban the use of CFCs worldwide through an international pact entitled the Montreal Protocol. By 1990, 49 countries had signed this pact. If it is successful, the Montreal Protocol will reduce total emissions of CFCs into the atmosphere by as much as 35% between 1989 and 2000.

**Methane.** The major avenue to reducing methane production is to cut back and/or completely halt deforestation. A more difficult, and probably unrealistic, solution would be to reduce livestock use worldwide.

... livestock are a source of the second-most important greenhouse gas, methane. Ruminant animals release perhaps 80 million tons of the gas each year in belches and flatulence, while animal wastes at feedlots and factory-style farms emit another 35 million tons.

World Watch, 1991

**Nitrous Oxide.** Reducing the use of oil-based fertilizers is one avenue to decreasing the output of nitrous oxide. Another would be the reduction of nitrous oxide emissions from power plants. In Japan, for example, the emission of nitrogen oxide from thermal power plants dropped approximately fifty percent in fifteen years due to the use of pollution control devices (WRI, 1990).

### **Reforestation**

Another means of decreasing the potential for global warming is to develop new multiple use forestry programs. Living plants and the surrounding soil constantly accumulate carbon. Worldwatch Institute assesses that 130 million hectares of forest, an area twice the size of France, could absorb 660 million tons of carbon each year (Flavin, 1989). Such estimates have spurred efforts to develop reforestation programs. For example, energy officials in Guatemala have teamed up with the World Resources Institute to create 12,000 hectares of woodlots to offset the country's major coal fired power plant.

### **Governmental Policies**

In order to accomplish the reduction of greenhouse gases, it appears that a concerted effort is necessary on the parts of all nations. Unfortunately, many countries are moving slowly with respect to greenhouse policies. Below is a table describing the current policies of selected countries with respect to the emission of greenhouse gases (Flavin, 1989, p.50). Of the variety of global policies available for countries to implement, one in

<b>Nation</b>	<b>Policy</b>
The Netherlands	Propose to freeze or cut carbon dioxide emissions and increase spending on efficiency.
Norway	Plan to stabilize emissions by 2000, then reduce emissions.
Sweden	Plan to freeze carbon dioxide emissions at current levels and to tax carbon dioxide emissions
United Kingdom	Considering control of methane leakage and improving energy efficiency.
United States	Comprehensive legislation to cut carbon emissions by 20 percent.

particular seems viable. In order to reverse the pattern of rewarding polluters, a "carbon tax" on fossil fuel use would seem to make sense ecologically and economically. For example, if a carbon tax of \$50 per ton of carbon were levied worldwide the total revenue would amount to 280 billion dollars a year. This money could be used for international research and development of global solutions to greenhouse build up.

### **Barriers to the Solutions**

As with any global issue, the complexity of the issue itself is a barrier to its resolution. Every country in the world is a source of greenhouse emissions. Any attempt to remediate or solve this problem must be approached on a global scale. The complexity of solving this problem is compounded by its relatively recent discovery. For example, at the

world's first ecological summit, the 1972 Stockholm Conference on the Human Environment, climate change was not even listed as a threat to global society.

A major barrier to the resolution of this issue is a lack of unity in the world scientific community. Although a majority of scientists would agree that there is an evident increase in the greenhouse gases, they are less unanimous that these changes will result in climatic changes and, more importantly, that these changes will have adverse effects on the biosphere. Recently, the Director of Studies for the Carnegie Commission on Science stated, "Much of the conventional wisdom about impacts of global warming would appear as yet to have little support from research. . . . It is very important [to learn] whether the climate change is expected" (Ausubel, 1991, p.220). This outlook however seems to be the exception rather than the rule. A majority of scientists appear to support statements such as that of the Scientific Assessment of Climate Change, organized by the World Meteorological Organization:

We are certain that emissions from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases. These increases will enhance the greenhouse effect, resulting on average in an additional warming of the earth's surface. (WMO/UNEP, 1990, p.2)

These debates have had an adverse influence on attempts to remediate global warming. In 1989, for example the president of the World Bank defended his institution's stance on not approving loans to greenhouse reduction projects because of the uncertainties of global warming (Flavin, 1989).

Even with possible unanimity from the scientific community, the nations of the world face another barrier to solving global warming: the unique task of approaching a problem as a world community. National differences and old rivalries will have to be set aside. Unfortunately, this approach will be a slow and painful one. For example, in 1989, 17 countries including France, Japan, and West Germany established the Hague Declaration calling for an international institution with enforcement powers to carry out the provisions of a global warming agreement. Leaders of the seven most powerful industrial countries, including the United States, did not endorse the institution for a variety of political reasons. Since then, other declarations and proposals have been made with little to show but a great deal of rhetoric.

A final barrier that must be mentioned is the economic costs of reducing the greenhouse gases. It has been estimated that a 50% reduction in greenhouse gas emissions will cost about 1% of the world's total annual economic output. This amounts to approximately 200 million dollars a year for the next 30 years (Miller, 1989).

**\*\*\*Global Change Issue Vignette\*\*\***

**Carbon Dioxide and Krakow**

*The only answer to Poland's environmental crisis is for society to organize on the local level to attack the hazards one by one.*

A. B. Durning, in *Worldwatch*, 1989

Just outside of Krakow, Poland's third largest city, sits the Lenin Steel Works. The mammoth facility looms over the surrounding countryside, dumping out tons of smoke and carbon dioxide a year. Krakow's air has been heavily polluted by unregulated heavy industry and by low quality coal. This air pollution has had an effect on the local children. The local public health department reported that during a four year period, sixty-one percent of the children surveyed had been under a doctor's care for chronic illness related to air quality (Sweeny, 1991). As one health official stated, "It seems that people in Krakow are sicker than those in other parts of the country" (Sweeny, 1991, p.58).

Although this appears to be a bleak picture, prospects for the town and its air quality may be improving. Since the downfall of the previous government, Poland is experiencing a growth of environmental concern and responsibility. The public health department is already embarking on a five year study of local residents and their physical reactions to air pollution. Other movements include the increased role of the Krakow Department of Environmental Protection.

The agency is making efforts to force the steel mill to reduce its emissions. The government has aided in this quest by declaring Krakow an "especially protected area". The results have been encouraging. The mill will soon cease processing its own coke, pig iron, and lime. This should reduce emissions by 35 percent.

The growth of local interest in environmental issues in Krakow and in the rest of the country has been met with resistance. With the fluid nature of the government and the economy, other concerns are often forced to the foreground. One in particular is the economic stability of Poland. Mr. Lech Jeziorny, vice chairman of the Krakow Industrial Society, believes that money is the most important barrier to environmental quality in Poland. He refers to this when he talks about the fate of the 30,000 workers employed at the Krakow Steel Mill, "The question is what to do with the workers, with the firms, with everything. Ecology cannot exist without economy" (Sweeny, 1991, p.60)

In actuality, this issue of air pollution is a sub-issue of the greater issue of global warming. In Krakow's case, human health is of major concern. At any rate, the dilemma faced by the people of Krakow is illustrative of that faced by individuals the world over. Although they must cope with immediate political and economic contingencies, a growing number of Poles are nonetheless concerned about the long-term well-being of the environment.

## **Tropical Deforestation**

*"Deforestation is second only to the burning of fossil fuels as a human source of atmospheric carbon dioxide."*

*World Resource Institute, 1990.*

The 4.244 million hectares of forest presently covering the earth surface can be classified into several distinct biomes: boreal, temperate deciduous, tropical rainforest, and savanna (Brown, 1991). Since the beginning of human existence, these ecosystems have been crucial to the day to day survival of humans.

Although long considered an inexhaustible resource, the earth's forests are rapidly being depleted and degraded. The reasons for these declines result from a variety of human interactions including agriculture, grazing, development, and other land use activities.

The deforestation of these biomes has created ecological and environmental impacts of local, regional, and global proportions. Tropical forests, historically the least impacted forests, are now in the greatest jeopardy due to their present accessibility. In 1950, thirty percent (30%) of the earth's land mass was covered with tropical rainforest, and by 1975, the figure was down to 12 percent (12%). It is estimated that only 6 percent of those original forests remained by 1990 (Miller, 1991). Today, tropical rainforests supply half of the world's annual harvest of hardwoods, hundreds of food products, and a variety of plants that are used for medical purposes.

... our intervention in tropical forests should be viewed as one of the most challenging problems that humankind has ever encountered. After all, we are the first species ever to be able to look upon nature's work and to decide whether we should consciously eliminate it or leave much of it untouched.

Norman Meyers, In G. Tyler Miller, 1988

### **What are Tropical Rainforests?**

Rainforests are drenched with at least 400 centimeters of rain annually. These forests characteristically form a closed canopy, allowing only a small amount of sunlight to reach the ground. Despite the lush appearance of these forests, their soil bases tend to lack nutrients since most of the minerals are stored in the vegetation. This characteristic of these soils is a critical variable to the stability of the rainforests. Although these ecosystems occupy a small percentage of the earth's surface, they account for at least two thirds of the planet's plant and animal species. As noted earlier, the tropical rainforests act as a carbon sink with the ability to absorb a portion of the carbon dioxide created by human activities.

### **A History of Tropical Deforestation**

The cutting of tropical rainforests is not a recent development. For thousands of years, aborigines have utilized slash and burn agriculture for subsistence. In fact, 7000 B.C. saw Iran and Iraq covered with productive forests and grasslands. Slowly, poor forest practices led to the desertification of the area (Miller, 1991). In recent times, changes of the tropical forest biomes have taken on similar characteristics. Since 1850, North Africa and the Middle East have lost 60% of their tropical forests, while South Asia and China have lost 40 % (WRI, 1990). Brazil's history of rainforest consumption reflects the trend of many equatorial countries. Before and during the colonization of Brazil, human impact on the forest was minimal, with native slash and burn agriculture being the primary source



of impact. However, this trend changed in the 1960's with the construction of highways into the interior of Brazil and easy access to the forest resources. Due to this accessibility, tropical rainforests today are being cut in greater quantities.

Trends in other parts of the world indicate similar fates for other tropical forests. In 1990, the *African Journal of Ecology* published a model that predicted the future of tropical rainforests by using the statistics published by the FAO/UNEP (1981). This report claims that seventy percent of the west African forests (from Senegal to Nigeria) will disappear by 2040. It is predicted that, during the same period, the eastern countries (Rwanda, Burundi, Uganda, Kenya, and Tanzania) will lose 95% of their combined forest cover. Only in central Africa does this prediction model indicate that large areas of forests will remain (Barnes, 1990).

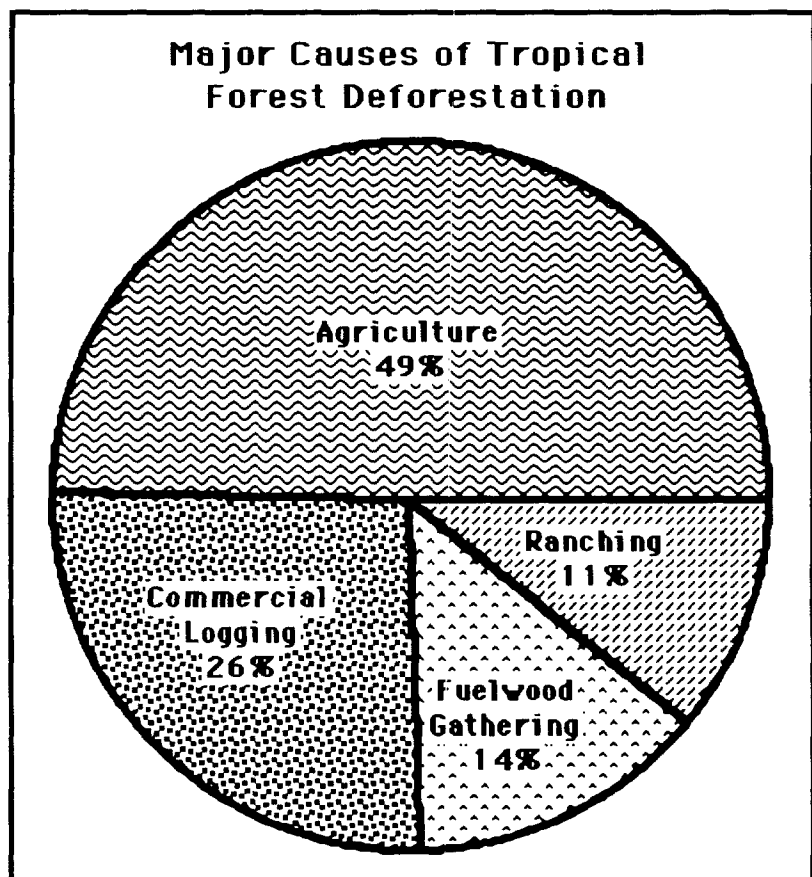
### Reasons for Deforestation

In 1987, an estimated 20.4 million hectares of tropical forest were lost worldwide (WRI, 1990). There are three primary causes for this current depletion of tropical rainforests. The first is permanent conversion of forests to farmland and grazing. Equatorial countries with burgeoning populations and limited open land resources are opening up great portions of forests for subsistence living, for cattle ranching, and for crops such as teak, rubber, rice, and coffee. It is often the case that when tropical forests are cleared for agriculture, little of the wood is actually harvested. Instead, it is simply burned. For example, in Honduras alone, an estimated 320 million dollars of wood is destroyed on an annual basis (Buschbacher, 1990).

Although logging the forests can, in itself, be a cause of deforestation, if practiced through a selective cutting process, the impact to the forest ecosystem can be minimal. However, much of the tropical forest is damaged, wasting a great deal of wood. In a typical logging operation,

only 10 to 21 percent of the trees are actually cut, with another 30 to fifty percent of the trees destroyed, opening the forest up to soil depletion (WRI, 1990).

A third cause of deforestation is the demand for fuelwood. Almost 70% of the people in developing countries rely on biomass as their primary fuel for heating and cook-



ing. About half of this comes from burning wood (Miller, 1991). This need for fuelwood in tropical countries increases the strain on existing rainforests.

### **Impact of Deforestation on the Biosphere**

The widespread depletion of tropical rainforests has local and regional implications, as well as wide-spread influences on the earth's biotic and abiotic systems. Deforestation directly affects local conditions by increasing runoff into nearby watersheds. The soil and other nutrient matter that is washed off, because of the loss of the protective canopy, increases water turbidity and pollution. Another destructive outcome, both ecologically and socially, is the increased potential for flooding. This is best illustrated in the mountain watersheds of the Himalayas where accelerated runoff due to deforestation causes serious flooding in bottomland countries such as Bangladesh. In September of 1988, Bangladesh experienced its worst flood on record leaving 25 million of the country's population homeless. Many experts have speculated that this disaster was aided by upland deforestation (NRC, 1989).

"Continued degradation and elimination of these interdependent and vulnerable tropical forests could eliminate several hundred thousand to over a million species [of plants and animals] by the year 2000."

GTC, 1990

A regional concern related to the loss of forest biomes is the "recycling" of rainfall. A healthy stand of rainforest can evaporate back into the atmosphere approximately three fourths of the precipitation collected (NRC, 1989). The loss of these "cloud producers" have scientists speculating that regional areas will lose precious rainfall.

Tropical deforestation also has the ability to impact regional nutrient cycles. The loss of the vegetation that supplies nutrients to the soil, coupled with the impact of direct radiation from the sun, decreases much of the capacity of the soil to sustain not only tropical vegetation but also human subsistence. This has led experts to believe that many tropical countries which have experienced extensive deforestation may be headed for a type of soil drought (NRC, 1989).

The loss of forested habitat has decimated hundreds of thousands of species of plants and animals. As an example, the world songbird population has experienced dramatic declines due to the destruction of these biomes. In lower Midwestern hardwood forests, U.S. birders have noticed a substantially lower population of warblers and other songbirds migrating through the area for the past several springs. A 1989 study conducted by the U.S. Fish and Wildlife Service found that a variety of bird species decreased due to the loss of forest habitat in North, Central, and South America. The analysis concluded that, "This research represents the strongest evidence to date that tropical deforestation is contributing to declines in migratory bird populations" (WRI, 1990, p.136).

Although many of the impacts of deforestation are regional, tropical deforestation has the potential for global ecological alteration. Deforestation produces several by-products that add to the greenhouse gases discussed earlier. Most dramatically, when tropical forests are burned to produce farm land or grazing land, carbon dioxide is emitted into the atmosphere. Brazil, for example, is contributing an estimated 336 million tons of carbon to the atmosphere a year. These figures contribute to Brazil's rank of fourth in the world in total carbon output (Flavin, 1989). Satellite reconnaissance has recorded the dramatic visual evidence of massive plumes of smoke entering the atmosphere due to the burning of the tropical rainforests. The burning of these forests may have accounted for as much as

ten percent of the global input of carbon dioxide in 1988 (Miller, 1991). Another harmful gaseous emission, directly related to deforestation, is that of methane. As noted earlier, termites cause the release of substantial amounts of methane. The destruction of tropical forests has enabled termite populations to grow exponentially, increasing methane emissions into the atmosphere.

All in all, tropical rainforest deforestation must be considered as a critical global change issue. It is an issue with numerous implications ranging from the gaseous emissions discussed here to the destruction of habitat for thousands of kinds of plant and animal species, including Homo Sapiens.

**Amount of Rainforests Cleared Annually During 1980's in Selected Tropical Countries**

<u>Country</u>	<u>Amount of Forest Cleared</u> (thousand hectares)
Brazil	8,000
India	1,500
Indonesia	900
Myanmar	677
Thailand	397
Vietnam	173
The Philippines	143
Costa Rica	124

WRI, 1990

**The Impact of Deforestation on Society**

The main reasons given for deforestation are usually associated with socio-economic variables. And yet, the impact of deforestation on the human community has been dramatic in a negative sense. As an example, modern accessibility of tropical rainforests has resulted in the demise of many of the indigenous tribes of tropical countries. The people who were once the stewards of the forests (and who had seen the health of the forests as a cultural imperative) have, themselves, become an endangered species. In Brazil alone, the Indian population has dropped from more than 6 million in the 16th century to approximately 200,000 today (GTC, 1990).

The siltation of water systems discussed earlier, has created problems for countries using these waterways for hydroelectric power. For example, in Costa Rica, soil erosion from a deforested watershed has greatly shortened the life of of one hydro-dam (GTC, 1990). The waterways are becoming filled with sediments, motivating some experts to predict that the Panama Canal will become silted by the year 2000 (GTC, 1990). Such massive siltation would also certainly have dramatic impacts on aquatic ecosystems as well.

The logging and subsequent burning of the tropical forests have produced other problems such as the increased possibility of damaging fires to grazing areas and agricultural crop lands which border the forests (Buschbacher, 1990). The logging itself has created economic problems for equatorial countries. For example, the vast majority of trees in the Amazonian region, although commercially valuable, are burned or left to rot, costing an estimated 100 to 250 million dollars annually (WRI, 1990).

The loss of the tropical rainforest has not only displaced thousands of animal species but has also impacted whole regional communities producing human "environmental refugees". This contributes to political instability. As an example, several million people have left their homes in Central America to escape poverty and environmental degradation. In Indonesia, over a million people have abandoned the deforested and eroded areas of Java and migrated to Borneo and other islands (GTC, 1990).

## Societal Causes of Deforestation

Although both temperate and coniferous forests have been subjected to deforestation at one time or another, many rainforests now face possible extinction. This resource is being depleted at alarming rates.

The causes of these high annual rates of deforestation are complex and include commercial logging, agriculture, and cattle grazing, among others. In many cases the reasons for deforestation are related to regional needs and concerns. Clearing for pasture is the major cause of deforestation in Central and South America. Shifting agriculture and population density are the major factors in Africa, whereas commercial logging appears to be concentrated in Asia (Buschbacher, 1990).

In Latin America alone, 20 million hectares of tropical forest have been cleared for cattle grazing (WRI, 1990). This accounts for approximately one quarter of the annual forest loss worldwide. The cause of this growth in grazing land is the world demand for beef, particularly from the United States, Europe, and Latin America. Government support for this activity has also been important for its growth. Until recently, Brazil offered large tax reductions for those who invested in cattle ranching. Similar to agriculture, the land used for grazing becomes depleted of nutrients within a few years, increasing the potential for soil erosion and land degradation.

Each year approximately 8 million hectares of tropical rainforest are cleared for agriculture (GTC, 1990). Much of this land is cleared to support large plantation farming. Large farms grow commercial crops that are exported around the world. In Central America bananas and coffee are the main agricultural product while Southeast Asia harvests rubber, palm oil, and cacao.

### Principal Causes for Deforestation in Selected Regions

<u>Region</u>	<u>Principal Causes for Deforestation</u>
Colombia, Ecuador	Commercial logging
Southwest India	Agriculture, fuelwood needs
Malaysia	Agriculture, logging
Philippines	Agriculture, logging
Madagascar	Cattle grazing, charcoal production
Brazil	Government policy to promote colonization

GTC, 1990

Not only is the forest cleared for the use of land, but it is also cut for timber and fuelwood. Industrial timber cutting is a major cause of tropical deforestation. Logging in the tropics degrades some 4.5 million hectares of forest a year (Brown, 1991). In recent history this industry has seen exponential growth, particularly in China, India, and Brazil. Unfortunately, in most of these cases, as well as with other tropical countries, the clear-cut method of removing this timber has led to massive deforestation. In 1989, the International Tropical Timber Organization concluded that less than one percent of tropical logging was done on a sustained-yield basis (Brown, 1991). In many of the tropical countries, and in particular Africa, the use of the forest for fuelwood has put great strain on the forest biome. Almost 70% of the people in developing countries rely on biomass as their primary

source of fuel. By 1985, 1.5 billion people could not get enough fuelwood to meet basic needs. In fact, the UN Food and Agriculture Organization predicts that, by the end of this century, 3 billion people will experience a fuelwood crisis (Miller, 1991). In addition to the destruction of millions of hectares of forest, there will be a tragic impact on humans as a result of the depletion of forest resources.

### **Solutions to Deforestation**

The paths to remediating deforestation are complex and difficult. In order to decrease the amount of deforestation taking place, several strategies might be useful. These strategies include establishing tropical forest reserves, restoring deforested lands, and curbing demands for tropical goods. Certainly one aspect to solving this crisis is the advancement and implementation of a human value focused on a sustainable [resource] ethic.

#### ***Debt for Nature Swap: Bolivia***

Bolivia is a tropical South American nation with a population of almost 9 million people. Bolivia has a multi-billion dollar foreign debt. During the mid 1980's conservationists suggested a debt for nature swap. This means that a certain amount of foreign debt is cancelled in exchange for local currency investments that will improve the nation's natural resources. In 1987, Conservation International paid \$100,000 to a Swiss bank to buy up \$650,000 of Bolivia's national debt. In return, Bolivia agreed to protect 1.5 million hectares of tropical rainforest. Unfortunately, by 1990, the Bolivian government had yet to actually protect the area due to complications with the local tribes in the forested region. Although this project is yet to be claimed a success, it does give indications that these types of transactions may be possible in other parts of the world (Brown, 1991).

Another solution to deforestation might be a shift in agricultural techniques. Instead of clearing standing forests for agricultural use, alternative agricultural sites might be utilized. There might also be a greater emphasis on low impact crops such as oils, fruits, resins and fibers, and less dependence on large farm plantations. Along with the focus on sustainable crops is the "farming" of rainforest species of plants that can be used for medical purposes. For example, plans are being drawn up by North American Pharmaceutical Companies to provide Costa Rica with funding for certain species of plants without negatively impacting the forest ecosystems (WRI, 1990).

The solution to the grazing issue is more complex. In some tropical countries, one motivation to graze cattle has already been modified as governmental support for raising livestock has been decreasing. Recently, Brazil discontinued certain economic shelters that supported grazing. Another possible solution to this problem is to reduce the world's demand for beef that stimulates this deforestation in the first place.

Instead of purchasing beef raised where tropical rainforests once stood, the United States now obtains most of its beef from Australia and New Zealand (GTC, 1990). However, many other nations still obtain beef from these cleared forested lands. The United States departure from tropical beef is an optimistic example of how public opinion can effect global policies. Reforesting the grazing lands, another solution, tends to be a more difficult task due to the serious damage that is done to the soil after the initial clearing of the forests.

Of the major causes of deforestation, the alteration of forestry methods seem to hold the most opportunity for change. Most experts now agree that forest management should be based on biological diversity. In the same way that agriculture must turn to sustainable

crops, so too should the forestry practices in these tropical countries work with the ecosystem and not against it. One example of this technique is a strip clear-cut method being tested in Peru. Here, narrow strips of forests are cleared, in an attempt to mimic natural cleared areas such as windblown sites. The objective of these cuts is to minimize the impact on the forest system, while still producing substantial yields.

There are other sustainable forestry methods taking place around the world. However, as with the Peruvian example, many factors must be taken into consideration for success in implementing these methods. Two major factors are economic feasibility and social acceptance. The former is simpler to substantiate, the latter is more difficult to attain. Figures clearly indicate that, in most tropical nations, the current massive clearing of the forests is not economically feasible (Barbier, Burgess, & Markandya, 1991). On the other hand, the political instability of many of these countries coupled with their independent natures makes it difficult for outside sources to aid in improving timber practices.

### **Barriers to Solutions**

The difficulties of remediating deforestation include social, economic, cultural and educational variables. For example, in the case of the attempts to change timbering practices, the possibility of nation-wide acceptance of this technique might be diminished due to the tenuous stability of the government itself. In Bolivia, the debt for nature swap has been impeded by questions of the cultural rights of the indigenous peoples in the forests in need of protection. In Africa, subsistence living and the accompanying fight for survival supersedes any attempt to protect the forests from being cut for fuelwood.

An additional barrier to remediating this particular global problem is the polarization between developed and developing countries. Although saving tropical rainforests is a popular battle cry for North American and European communities, it tends to be perceived with irony by many of the tropical countries. For example, Brazil has reacted negatively to international demands that the Amazon be left as a storehouse for biodiversity. In fact, at one international meeting, Brazilians remarked that they intended to develop its resources like any temperate country, noting that the U.S. citizen uses 15 times more energy than Brazilians and thus shows little concern for global ecology (WRI, 1990). This is not to say that Brazil and other tropical countries are not concerned with their forest resources. It does, however, emphasize a major development issue that will be difficult to solve without international cooperation.

### ***The Costa Rica Project***

This tiny Central American country has experienced a serious depletion of its tropical forests. By 1983, only 17% of the nation's original tropical forest remained. However, since the mid- 1970's, the government has taken great strides to protect the remaining forests. Today, almost 12% of its land mass is protected by national preserves. It is hoped that, by the end of the century, this figure will rise to 25%. This effort, has resulted in certain benefits that include increased income due to tourism (Miller, 1991).

**\*\*\*Global Change Issue Vignette\*\*\***

**Rainforests in Malaysia**

*... A clash of different systems, of different civilizations - on one side a powerful modern system motivated by greed - on the other a traditional system that is oriented towards fulfilling human needs. Despite the so-called greatness of knowledge of modern science and technology, the modern man is far less knowledgeable, in fact far more stupid, than the indigenous, native man who lives close to nature.*

Mohammed Idris, Malaysia 1990.

**The Nation**

Malaysia is a federation of states. The states, rather than the federal government, have total control over the land and over how it is used. Recently, Malaysia has received a good deal of world-wide criticism for the manner in which it is managing logging in its tropical rainforests. In fact, in the 1970's the federal government admitted that less than 10% of the logged areas received any encouragement for regeneration of cut trees. Although the country enacted a National Forestry Policy in an attempt to deter irreparable damage to the forests, many of the problems still continue. For example, a recent court case in the Pahang state revealed that a saw mill company that had logged more than 6,000 hectares of forest had replanted only four hectares (Rubeli, 1989).

The Malaysia government itself disputes these claims of having a poor conservation ethic, stating that, out of the 364,000 hectares logged between 1981 and 1985, 96.9% were rehabilitated (Rubeli, 1989). In fact, there are signs that conservation is making progress in Malaysia. In collaboration with the International Union for Conservation of Nature and Natural Resources, the World Wide Fund for Nature - Malaysia (WWF Malaysia) is drawing up a series of strategies for conserving natural resources. This project is attempting to make conservation more holistic, with shared responsibility between the states or the arms of the government. Although this approach will take some time to implement, it is receiving support from the federal government.

**The Region**

In the heart of the Borneo rainforest in Malaysia lies the province of Sarawak. Due to its location in one of the most productive forests in the world, Sarawak is the largest source of unprocessed tropical timber on the international market. This resource has been dominated by Japan which takes about two-thirds of Sarawak's current annual output of more than 15 million cubic metres of timber. Sarawak's Minister for the Environment is James Wong. He is a controversial figure who has been under scrutiny for his ties with the logging business. Wong pioneered the timber industry in Malaysia, and has been in business since 1949. He insists, however, that the logging does not destroy the forests and, in fact, states, "All the animals and birds are back . . . with more fruits and nuts than before . . . logging is good for the forest." (Pearce, 1990, p. 46).

Many experts disagree with Wong's optimism toward logging outcomes in Sarawak. One critic, S.C. Chin, a colleague of Wong's at the University of Malaysia states that, "The forest situation is now critical. . . - At the present rate of logging, the pri-

mary forest will be finished in seven or eight years" (Pearce, 1990, p. 46). Chin calls Sarawak's forestry industry "hit-and-run" logging. He feels the logging practises are poorly managed and cause a great deal of damage. Much of this damage can be observed in the land and the waterways of Sarawak.

Another issue in the Sarawak deforestation saga is identifying the actual culprits of the destruction. The state government and the timber industry blame it on the native's practice of clearing land for subsistence. Conservationists put the responsibility on the logging industry, citing figures that claim that native clearing averages to about 72,000 hectares a year while the timber industry clears approximately 500,000 hectares a year (Pearce, 1990). No matter who is right in this issue, there is no question of the importance of logging to Sarawak and its economy.

### **The River Valley**

In a recent news release in the Chicago Tribune, a member of the Penan tribe reflected on the logging situation in the Malaysian rain forest in the state of Sarawak. A portion of that news release is as follows:

The young Penan tribe member loaded a poison dart into his blowpipe. He took aim at a small bird flitting through the jungle canopy and blew. The bird fell.

"It's not so easy living off the forest now," said Moss, 25, pulling another dart from the case slung over his shoulder. "We used to be able to find wild boar and other animals in just a few minutes. Now we can hunt for days and find nothing. We have to walk much farther for the fruit trees and plants for medicine we have always used."

"The logging is destroying them. That's why we are trying to stop the logging." (Magistad, 1990, p.5)

A western scientist, further commenting on the Penan, remarked, "Far from being wild nomads, the Penan have an intimate association with and detailed knowledge of their forest. . . . it was universally acknowledged . . . that the Penan were their forest professors. It is with the Penan that the real wealth of the rainforest lies" (Pearce, 1990, p. 49).

Harrison Ngau, a member of the Kayan tribe has lived his life in the native longhouse which is located on the River Baram in the heart of Sarawak. He enjoyed his aboriginal way of life and his ties with the rainforests. However, Ngau's life and the lifestyles of his longhouse are changing. In the early 1980's the people of the Baram valley began to see the timber industry clearing the area's tropical forests. Ngau saw his elders corrupted by bribes to help with the logging. Normal subsistence lifestyles were being disrupted by the timber harvesting which decreased crop yields and increased hunger among the tribespeople. The destruction of the forests had been blamed for declining local markets in fish, nuts, resins, rattan, and bamboo goods. The longhouse also has begun to see social problems, such as alcoholism, erupting. A report from Ngau's district elders stated:

The logging operators bring along tonnes of their equipment and plant [sic]. . . . building crisscross roads and railways, bulldozing hills, mountains and plains with devastating effect. Sometimes it has to cross over the customary land, paddy farms, gardens, cemeteries, pipelines and catchment areas and other other private properties. Extraction of timber has caused extensive and irreparable damage to the natural land surface and vegetation. (Pearce, 1990, p.48)



Beginning in 1986, the local people began to fight back. Initially, they arrived at logging camps demanding restitution for the damage they had caused. But soon they became organized, with the help of Harrison Ngau. They started to protest passively, stating that the loggers were ignoring native land rights. They started to blockade the logging roads, attempting to halt the timber operation. As the protests grew, so did the number of tribes supporting the fight. The Penan tribe, a small group numbering some 10,000 hunter-gatherers from the remote parts of Baram managed to stop the clearing temporarily by blockading access to the forests. From there, the protests swiftly spread and by May of 1988 members of the Penan, Kelabit, Kayan and Iban tribes had joined in attempting to stop the logging.

Harrison Ngau's office in the forest frontier town of Marudi has become a center for the tribal protests and, in a sense, has become, a mouthpiece to the world. Through his connections with Friends of the Earth the native protests have become known worldwide. Ngau has brought pressure on not only the provincial state, but also on the federal government. The international attention that this Kayan and his followers brought about has forced the state to invite the International Tropical Timber Organization (ITTO) to Sarawak to make recommendations for the management of the state's forests. However, the state and federal governments also decided to continue logging in the Baram. This, in turn, has led to further protests by Harrison Nagua and his tribespeople.

### **Analysis**

The clearing of tropical forests in Malaysia has elicited a series of complex social and environmental issues. Some of these issue topics include:

- Federal vs. provincial states rights to make land use management decisions.
- Native land rights vs. government domain.
- Subsistence values vs. industrial/business values.
- Long-term ecological values vs. short-term economic values.
- Local politics/concerns vs national and international politics/concerns.

Another aspect of this case study, and certainly a crucial one, reflects the power of environmental action taken at the local level. The attention from the international community, brought upon by local tribal protests, drew negative reactions from the Malaysian government. Like many of the tropical countries involved with the deforestation issue, Malaysia is acutely aware of its colonial past and is extremely proud of its independence. It, as well as other emerging nations, reacts disdainfully if it senses pressure from other nations, and in particular, those from the developed world. As one former resident of Malaysia summed up this problem:

Recognition is one thing; interference another. Criticism from other nations can damage or destroy the work of local conservation groups. The international condemnation of logging in the Baram and Limbang regions of Sarawak, which disrupted the lives of many long house communities and the Penan hunter-gatherers, produced a knee jerk reaction from the authorities. (Rubeli, 1989, p. 52)

It was noted earlier that the adage "Act Locally, Think Globally" has merit. In this case, at least for the environmentalists involved, that action may have resulted in too much pressure. When Harrison Ngau and his longhouse embarked on protesting the logging in their river valley, they probably didn't expect the reaction they got from their own government. The strategy of working directly with the international community and by-passing

regional and federal government (with perhaps the best intentions) caused a great deal of controversy. As a former educator in Malaysia explained, "Conservation groups [in Malaysia] have an unwritten rule that says environmental issues should be fought first at the local level; then nationally; and internationally only as a last resort" (Rubeli, 1989, p. 52).

Local grassroots efforts regarding global change issues can have an impact. This Malaysian case study underscores this point. It also suggests, however, that thorough planning and analysis should precede environmental actions. The courage and motivation of Harrison Nagua is undeniable. His efforts and the efforts of his tribespeople are a testimony that individuals, no matter what their cultural/political status, can have an impact on national and international issues.

### **Human Population as a Global Change Issue**

*"Population growth seems to be the single most important factor in increasing environmental stress, including depletion of materials and energy resources and a runaway increase in solid, liquid, gaseous, and heat waste."*

*Global Change and Our Common Future,  
National Academy of Sciences, U.S.A., 1989.*

By the mid-1990's the world's human population will total 5,292,200,000. This figure is estimated to increase to 8,488,600,000 by the year 2025 (WRI, 1990). This represents nearly a tripling of the earth's population since 1960. If current rates continue, many countries in Africa and Latin America will double their populations in less than 25 years (GTC, 1990). The magnitude of these figures as well as the exponential nature of the population growth are enormous factors in global change. The impact of human population growth on the biosphere, as well as on society itself, is a complex matter that motivates many experts to look at global change primarily as an overpopulation issue.

Overpopulation might be said to occur when people in a given area use the available resources in their environment to the extent that it results in a degradation of those resources. In time, this degradation effects the life support systems of that population. Many scientists and sociologists believe that the world community is experiencing two types of overpopulation: people overpopulation and consumption overpopulation.

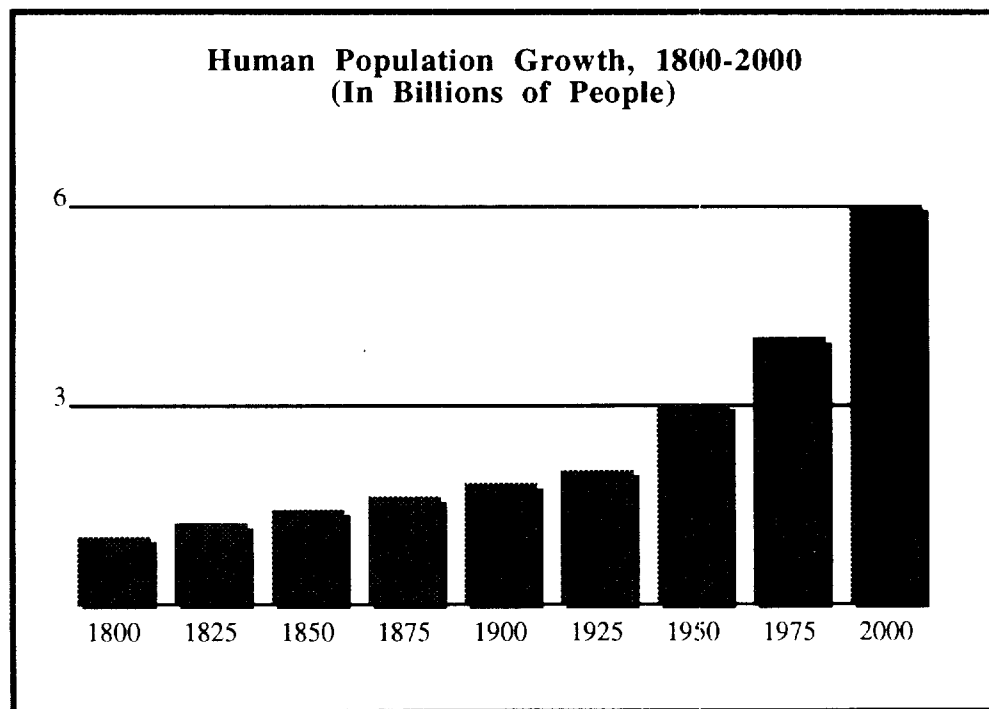
People overpopulation exists where there are more people than the area's resources (food, water, shelter) can support. Consumption overpopulation occurs when a relatively small number of people degrade and/or deplete a large amount of resources. Data tend to show that developed countries are experiencing consumption overpopulation while the developing world is faced with an acute people overpopulation. For example, the United States has only 4.8% of the world's population but uses about one third of the world's processed nonrenewable energy. The United States also produces at least one third of the world's pollution and solid waste (Miller, 1991). This document will devote the remainder of this section to a discussion of people overpopulation and will review consumption overpopulation in its discussion of energy use.

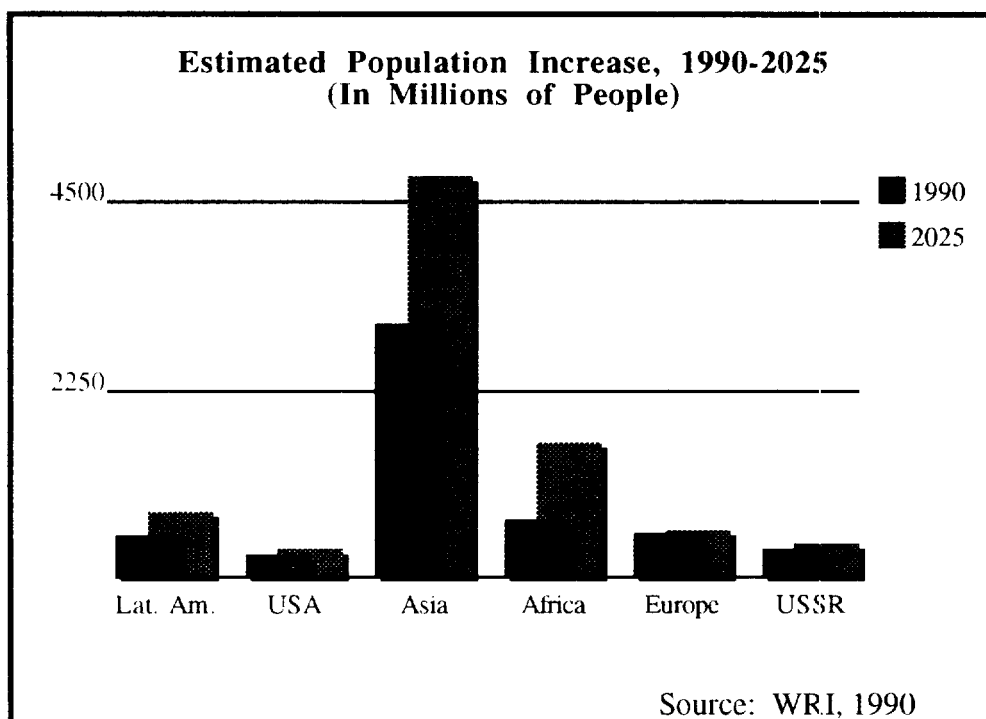
The concern over the possibility of overpopulation is not a new idea. Nearly 200 years ago, Thomas Malthus published a work which argued that population tends to grow exponentially while food production grows at a much slower rate. He predicted that, unless human population growth was checked, the world community would suffer from famine and malnutrition. Although much of his argument has been abated by modern technology and agricultural practices, other aspects of his predictions have been shown to be valid. Today, parts of Africa and Asia periodically experience tragic famines and plagues due to their massive populations.

### **The History of Human Population Growth**

The history of population growth dates back to initial human existence some three million years ago. Until 8000 BC members of the human species numbered less than ten million. Following the development of agriculture, the human population increased and numbered an estimated 300 million by 1 AD. By 1800, the world population had reached one billion people (GTC, 1990). It was at this point that rapid growth occurred. The total reached two billion in 1925, three billion 35 years later, four billion in 1974, and five billion only 13 years later. This exponential growth is illustrated in the diagram below. (GTC, 1990, p. 25)

By 1990, the world's population was growing at a rate of 1.8% annually. At that rate it would take nine months to add 75 million people - the number killed in the bubonic plague in the fourteenth century - or 21 months to add 165 million people - the number of people killed in all wars fought for the past 200 years (Miller, 1991). This population increase will take place primarily in the developing countries of Africa, Asia, and Latin America, whose rates of growth are higher than those of Europe, the U.S.S.R., and the United States.





As can be observed from the above graph, developing countries are experiencing greater increases in population than developed countries. Some of the causes for these disproportionate figures are listed below:

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**Variables Related to Population Growth in Developing Countries**

- \* A lower rate of education.
- \* A greater emphasis on children as being part of the family's labor force and often-times a concomitant desire to produce males.
- \* A tendency to have more children in order to offset the high infant mortality rate.
- \* A lower marrying age which increases the number of childbearing years.
- \* Limited access to birth control information and techniques
- \* Religious beliefs and cultural norms which impinge upon reproductive behavior.

**Variables Related to Population Growth in Developed Countries**

- \* Higher educational levels.
  - \* Higher costs associated with child-rearing and education.
  - \* A lower level of fertility.
  - \* A tendency to delay marrying to a later age, thereby limiting the number of childbearing years.
  - \* Greater access to birth control methods.
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The relationships between human population growth and social/economic variables appear to be far from simplistic. A 1985 study, published in the *Pakistan Economic and Social Review*, examined the relationship between fertility and agricultural modernization in developing countries. The results of the research indicated that developing countries which improved food production, in turn, decreased the probability of malnutrition and decreased overall fertility rates. The study concluded, "The increased food supply made available by

agricultural modernization lowers infant mortality and thus dampens fertility" (Ali, 1985).

### **The Impact of Overpopulation on Society and the Biosphere**

Humans constantly interact with their environment. In other words, they continually use resources from the biosphere to survive. It would certainly not come as a surprise that as the number of humans increase, the impact on the environment would increase. In a sense, the human species, as any other species population, responds to a certain "carrying capacity". Carrying capacity refers to the long term ability of an ecosystem to support a population without degrading its available resources and, in turn, affecting its own population. Carrying capacity is a function of human and environmental factors.

Unfortunately, human history has already witnessed a number of regional cases where the human population has exceeded its carrying capacity. For example, the Mayan civilization which existed for 17 centuries collapsed largely due to overpopulation and the concomitant environmental degradation (GTC, 1990). Many experts believe that as the world human population increases, more and more regional populations will exceed their carrying capacities and there will be serious environmental degradation as a result.

We need that size of population in which human beings can fulfill their potentialities; in my opinion we are already overpopulated from that point of view, not just in places like India and China and Puerto Rico, but also in the United States and in Western Europe.

George Wald, Nobel laureate,  
biology. In: G. Tyler Miller, 1988

The Stanford Carrying Capacity Project was developed to look at the impact of the human population on natural resources. The project estimated that humans have now used or destroyed approximately forty percent (40%) of the earth's net productivity (NRC, 1989). Each year the economic utility of a total of 27 million hectares is lost because of excessive human impact (NRC, 1989).

Two of the global change issues discussed earlier, deforestation and desertification, can be closely linked to human over-population. Tropical countries with high population growth rates tend to have higher deforestation rates (GTC, 1990). Countries in Africa as well as Central and South America seem to have interrelated rates of population growth and deforestation. For example, in Central America, between 1950 and 1985, the human population increased by 183 percent while about 40 percent of tropical forest was lost (GTC, 1990). Similarly, excessive farming and grazing depletes the soil of nutrients and can result in desertification. The human population in some parts of Africa has increased by 149 percent while nearly 90 percent of the productive farmlands in the region are degraded (GTC, 1990).

The Indian Academy of Sciences noted the influence of population pressure when they conducted a botanical survey for the Himalayan region of northern India. Their conclusions regarding major threats to flora are described below:

"The accelerating decline of India's natural wealth during the last few decades is a matter of grave national concern. The reasons for the precarious condition of the natural wealth are too many. Foremost among them is the ever increasing population pressure resulting in the acute need for more and more land both for settlement as well as agricultural purposes." (Hajra & Rao, 1990)

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**Viewpoint: Carrying Capacity Oversimplified**

*"The real problem is much larger; population pressure is as much as a result as cause, and population numbers, though important, are only one part of the whole"*

*Harold Brookfield, 1992*

Harold Brookfield, professor emeritus in the Research School of Pacific Studies at the Australian National University, argues that many environmentalists have oversimplified the theory that more people means more environmental degradation. As evidence, he points to the fact that degradation can arise under both high and low population densities and under both poverty and affluence.

Brookfield reflects the views of others who argue that there is more associated with environmental degradation than demographic changes.

*"Part of the damage now being done to more and more of the environment is due not simply to increased numbers, but to the greater mobility of people and their activities and the enhanced means they have of dealing damage through such simple innovations as the chain saw, as well as the tools of modern industry. Growing numbers are certainly a major element, but are not themselves a sufficient explanation."*  
(Brookfield, 1992, p. 28)

Brookfield warns that there is an inherent danger in viewing overpopulation and environmental degradation as a simple dualistic relationship. To do so ignores access to resources and capital as causes of poverty and disregards the role of technology in attempting to solve this degradation. Brookfield believes that advances such as the Green Revolution are societally produced influences that could sway imminent degradation.

He also cites a body of studies pertaining to carrying capacity that "shifts away from determinism towards questions of sustainability" (p.26). These studies focus on variables such as levels of support obtainable from environmental sources under varying conditions, and density limits dependent upon the success of the local inhabitants. In other words, Brookfield believes that many of the carrying capacity models are oversimplified and do not take into account a variety of other social and economic factors.

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Overpopulation within a region can also contribute to both human migration and over-urbanization. In regions such as Africa, the destruction and desertification of the land has led to thousands of environmental refugees who are attempting to find more fertile soil. As Worldwatch Institute described the tragedy:

Mass migrations have become the enduring symbol of hunger. In Ethiopia, relief workers watch the movements of villagers toward food distribution centers as one indicator of conditions in rural areas. . . . "stone deserts" have replaced nearly four million hectares of what was once fertile farmland. (Jacobson, 1988, p. 9)

Mass migrations not only contribute to further environmental degradation but also frequently create political instability. Of the 31 countries rated highest in political instability, nearly all had severe population pressures (GTC, 1990). These human migrations tend toward urban centers. The proportion of the world's population living in urban areas grew from 29 percent (29%) in 1950 to 42 percent (42%) in 1985. It is estimated that almost 90 percent of the third world population increase over the next few decades will be experienced in urban areas (GTC, 1990). There are a number of negative outcomes of this growth including the increase in disease, human stress, and urban pollution.

### **Solutions to Overpopulation**

In 1988, the World Bank president, Barber Conable, described the unabated population increase as a leading cause of economic disaster and social instability, and urged developing countries to "renew and expand efforts to limit population growth" (Brown, 1989, p. 188). Many international organizations share in Conable's concern. According to the Worldwatch Institute, "... the only socially responsible step for the United Nations, the World Bank, and the international development community is to call for a sharp reduction in the world growth rate" (Brown, 1989, p. 189). Although there is little denial that human population growth tends to have an adverse effect on the biosphere, there is a considerable amount of consternation as to the social implications of limiting this growth rate. Unlike other global change issues, the question of human population growth sets up a series of debates, both moral and religious, that are not present when discussing the pros and cons of deforestation or fossil fuel utilization. These controversies will be examined more closely in a subsequent section entitled "Barriers to Solutions".

### **Mexico City and Its Population**

In 1969 the population of Mexico City was approximately nine million. By 1990, however, the population had risen to 21 million. This dramatic increase has led to massive pollution, a higher crime rate, and deplorable living conditions for one third of the population. The polluted nature of the city's air and water causes an estimated 100,000 premature deaths a year. According to the World Health Organization, seven out of ten infants born in Mexico City have unsafe levels of lead in their bloodstream.

Miller, 1991

### **Indonesia and Its Population**

Indonesia is the world's fifth most populous country. Interestingly, it also has one of the most successful family planning programs in the region. Despite its success, the country still faces a 1.8% increase in population each year with the possibility of seeing 288 million people in its borders by 2020. In an effort to avoid this population explosion, the government has considered instituting a sex education program for the burgeoning adolescent population, the primary reason for the predicted increases. There is a reluctance to implement this type of strategy, however, in deference to the predominantly Muslim population and their religious stance on such education.

Miller, 1991

The basis to population stabilization within a nation may well be a sound national educational program. A populace which understands the interrelationships between human population, environmental quality, and economic stability is probably better prepared for making difficult decisions related to family size than is a less-knowledgeable group of individuals. In reference to a sound national population education program, Brown et al (1989) suggest that "The starting

point for a successful population education program is a careful look into the future [and] a set of alternative projections that relate population growth to environmental support systems and economic trends" (p.190).

**Family Planning.** Several options are available for attempting to stabilize the world's population growth, and it is probable that none of these has greater support from the international community than does family planning. Family planning programs provide educational and clinical services to millions of people. Most of these programs provide information and services related to birth spacing, birth control, and contraceptives. In some cases, these programs perform sterilizations and abortions. Family planning could be provided to all couples in developing countries for about 8 billion dollars a year. Currently, only 3.2 billion is being spent (Miller, 1991).

"Any meaningful effort to slow population growth quickly will thus depend on heavy additional investments in the provision of family planning services, improvements in education and health, and financial incentives that encourage couples to have smaller families."  
(Brown, 1989)

An acknowledgement of the importance of population stabilization and of family planning can be seen in the recommendation by the Environmental and Energy Study Institute, an organization established by the United States Congress. The Institute has recommended that the U.S. "... support the goal of stabilizing the world population in the next century through meeting the worldwide demand for family planning services" (Environmental and Energy Institute Task Force [EESITF], 1991, p. 18). The Institute further recommended that the United States contribute

1.2 billion dollars annually to help stabilize world population.

One example of successful family planning can be seen in China. The China Family Planning Association, a non-governmental organization, has 500,000 grassroots branches and a membership of 20 million. In coordination with government agencies, the association plays an active role in promoting family planning. In fact, recently, the association received the International Population Stability Award (Cheng Gang, 1990).

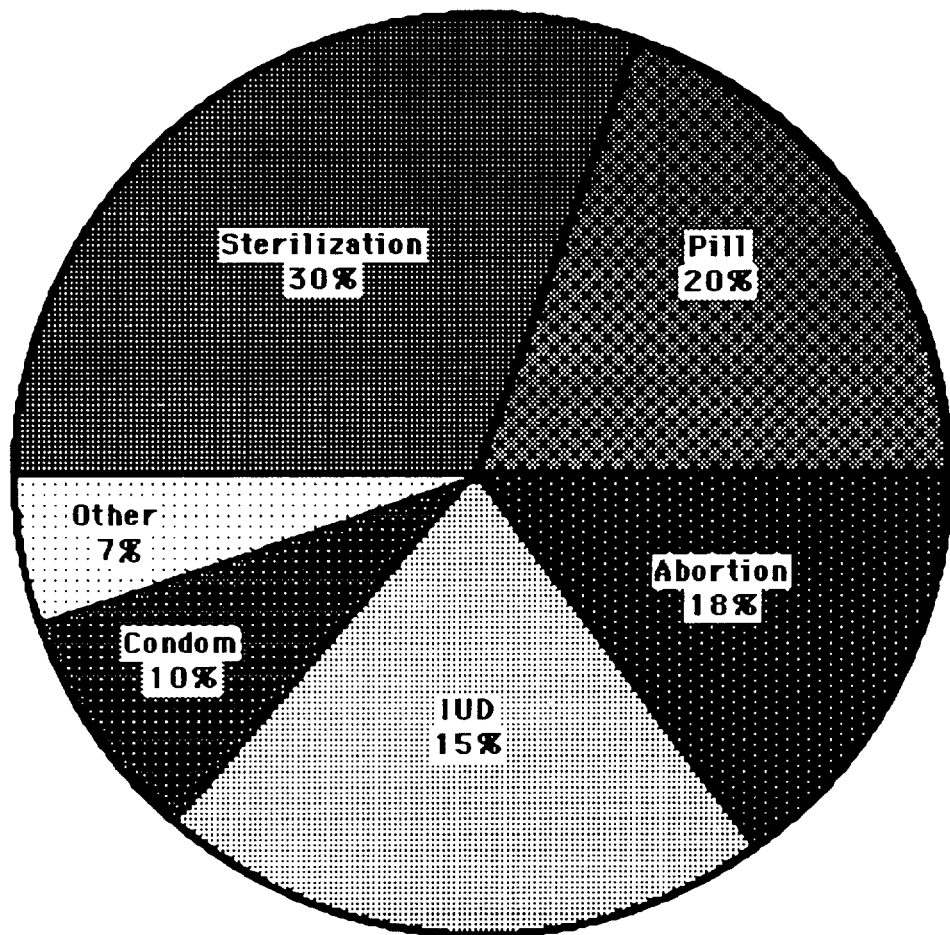
**Social and Economic Incentives.** A second strategy to realizing population stabilization is attempting to lower a country's birth rate by providing social and economic incentives to encourage smaller families. These perks often come as special tax incentives or social security benefits to couples with small families. In some cases disincentives to larger families are utilized, as well.

**Involvement of Women.** A third strategy is the involvement of women in educational, social, economic, and political activities. This is often a more difficult strategy to implement due to a variety of cultural barriers which might be present in a society. As noted by the Global Tomorrow Coalition, "Employment and education opportunities for young women are the most significant factors influencing their age at first marriage. The more education women have, the more opportunities they have besides child bearing, and the fewer children they choose to bear" (GTC, 1990, p.34).

Despite the formidable task of lowering the world's population, there have been several success stories where countries have managed to reduce their fertility rate. In Asia, the countries of Taiwan and South Korea have seen decreases in their birth rate. The most dramatic reductions have occurred in East Asia and Latin America where eight countries lowered their total fertility rate by 50 percent between 1960 and 1987 (GTC, 1990).



### Birth Control Methods On A Worldwide Basis



This chart displays the estimated use of various birth control methods in the world where birth control methods are in use. One must remember, however, that there are many nations in which fewer than 10% of reproductive females use birth control methods of any type.

### Barriers to Stabilizing Population Growth

No other species on the planet has such an effect on the biosphere as does *Homo sapiens*. No other global change issue faces the degree of cultural scrutiny as does human population growth. The social and religious stigmas to limiting human population are the barriers to remediating the world's overpopulation problem. Many countries around the world have experienced these conflicts in one form or another.

Countries which have made the shift [to small families] typically have four things in common: an active national population education program, widely available family planning services, incentives for small families (and in some cases, disincentives for large ones), and widespread improvements in economic and social conditions.

World Watch, 1989

The reluctance to implement population stabilization strategies due to the reactions of religious groups is apparent throughout the international community. The World Bank and the United Nations, for example, have avoided major population stabilization projects due to "deep-seated religious resistance in the Catholic church and in many Moslem countries" (Brown, 1991, p. 17).

Another hindrance to world population stabilization is the attitude taken by many that the rising population can be a positive factor to the world community. A number of observers main-

tain that people are the world's most valuable resource arguing that human beings, rather than being drains on the biosphere, actually help increase economic productivity. Since technology has dispelled Malthus's theory, many believe that up to 30 billion people could live on the earth without disrupting the biosphere (Miller, 1991).

These debates on whether human population increase is of a positive or negative nature, as well as the strong moral arguments associated with its stabilization, highlight the sensitive and controversial nature of the overpopulation issue. More importantly, as the issue continues, so do the ecological and economic ramifications of continued human population growth, and the accompanying potential for serious ecological damage in regions of the earth.

### China and Its Population

By far the most successful example of stabilizing an out of control population has been implemented by the most populated country in the world: China. Between 1972 and 1985 China achieved a remarkable drop in its birth rate; from 32 to 18 per 1000. In order to achieve this drop China implemented the most thorough birth control program in the world. Some of the aspects of this program included:

- Strongly encouraging couples to postpone marriages.
- Providing married couples with family planning services.
- Giving economic rewards to couples who have only one child and exerting pressure on those that have more than two.
- Requiring one of the parents in a two-child family to be sterilized.

By 1990, however, there was a slight increase in fertility rates due governmental relaxation of some of the more stringent policies. In any case, this represents a mammoth task that saw positive results in the stabilization of a nation's population. (Miller, 1991)

**\*\*\*Global Change Issue Vignette\*\*\***  
**Women, Education and Family Planning in India**

*Until female education is widespread; until women gain at least partial control over the resources that shape their economic lives, high fertility, poverty, and environmental degradation will persist in many regions of the world."*

World Watch Institute, 1987

According to the 1981 census data for India, age at marriage for over 80% of rural women was well below 18 years of age. This low age at marriage brings about a variety of problems which include prenatal mortality, low birth weights, and an increase in unwanted pregnancies.

An important strategy to avoiding some of the problems associated with female adolescents and population concerns is the promotion of education. A review of research conducted in India and elsewhere has indicated that fertility decreases with an increase in female education (Jain, 1989). These studies have found that educational level is negatively related to the desire for large families. On the other hand, educational level is positively related to the use of contraception. Unfortunately for India's overpopulation plight, "In India, women are last in line for education...despite the fact that raising the status of women is the most effective way to reduce births" (Jacobson, 1991, p.22).

Even in a country such as India, where population problems are intertwined with numerous cultural and educational challenges, dramatic impacts can be made at curbing the population growth while increasing the health and status of Indian females. In the villages of Jaghadia, a district of Gujarat state, a non-governmental group tends to the family planning needs of approximately 40,000 people. The Society for Education, Welfare, and Action-Rural (SEWA-Rural) has a network of community health centers throughout the district. SEWA-Rural has implemented several unique strategies to fight poor health in the region, and to curtail the local population growth. One of its most important policies is that of hiring doctors, health workers, and birth attendants from local communities. Thus, SEWA-Rural strives to maintain a close and constant relationship with the villages in order to prevent animosity and to promote a sense of trust within the region.

One of the more innovative programs that SEWA-Rural has adopted is the increased access of education to adolescent girls. This program also includes the establishment of empowerment groups that are attempting to foster change at the village level. Much of this work is directed at increasing woman's autonomy. Other steps to increase the status of women include offering female elders the opportunity to become teachers for the younger women. SEWA-Rural is also making serious efforts to train and hire more female teachers to set up literacy and tutoring campaigns.

Results from SEWA-Rural efforts have been quite impressive. The organization has reduced the infant and maternal death rates by half. Within the first decade of operation, they have seen the region's birthrate fall by one third (Jacobson, 1991).

The global change aspects of human population growth represent some of the most volatile social/cultural issues known to man. As discussed earlier, the attempt to abate the world's population growth conflicts with many perspectives on religion and cultural norms. These conflicts produce a large range of social and environmental issues.

The work of the SEWA-Rural indicates the success that can be accomplished even with numerous challenges and barriers facing them. The decreases in fertility and infant mortality were accomplished, to a great extent, by the reliance on local people and resources. As noted in other attempts to affect global change issues, the impact that local grassroots efforts have on solving these problems cannot be underestimated.

## Global Energy Consumption

*"The world is now lurching from one energy crisis to another, threatening at every turn to derail the global economy or disrupt its environmental support systems. The nineties are likely to be plagued by more frequent and more severe crises than ever before."*

*Worldwatch Institute, 1991.*

Since the beginnings of human existence, the dependence on energy to survive has been a matter of every day life. In the beginning, humans used their muscles to gather and hunt for food and they ate the food raw. Later, societies would use wood to help produce heat and prepare food. The use of this renewable resource lasted for thousands of years until the Industrial Revolution. It was at this time that the world community, and in particular the developed countries, began to rely on fossil fuels that were capable of higher energy outputs.

The availability of fossil fuels, along with the relative ease of their transportation and containment, made them the "diet" of the new industrialized world. Since 1900, the consumption of fossil fuels has increased nearly four times as fast as world population (GTC, 1990). Today, fossil fuel energy accounts for nearly 85% of the world's energy consumption. This dependence on nonrenewable fossil fuels for energy consumption is another critical variable associated with global change.

"... A baby born in the United States will damage the planet 20 to 100 times more in a lifetime than a baby born into a poor family in an LDC. Each rich person in the United States does 1,000 times more damage than a poor person in an LDC."

Paul Erlich, in Miller, 1991

Yet another variable exists which is related to both energy consumption and global change. This variable is consumption overpopulation. Consumption overpopulation exists when a relatively small number of people use resources at such a high rate that significant pollution, environmental degradation, and resource depletion occur. The use of fossil fuels by developed nations is an excellent example of this variable.

### Major Sources of Energy

Three major fossil fuels are used worldwide: oil, natural gas, and coal. Petroleum products alone account for approximately 35% of the energy produced in the world. Coal and natural gas represent 30% and 20% respectively. Because of the importance of these fuels to the world community, a brief review of the status of each resource will be presented along with information about the impact these resources have on society and the biosphere.

#### Oil

Oil is fuel consumed for commercial energy. Almost two thirds of the proven oil reserves are located in the Middle East, with the remainder located in the United States and the Soviet Union. At current production rates, world oil reserves are estimated to last approximately 35-50 years.

## Coal

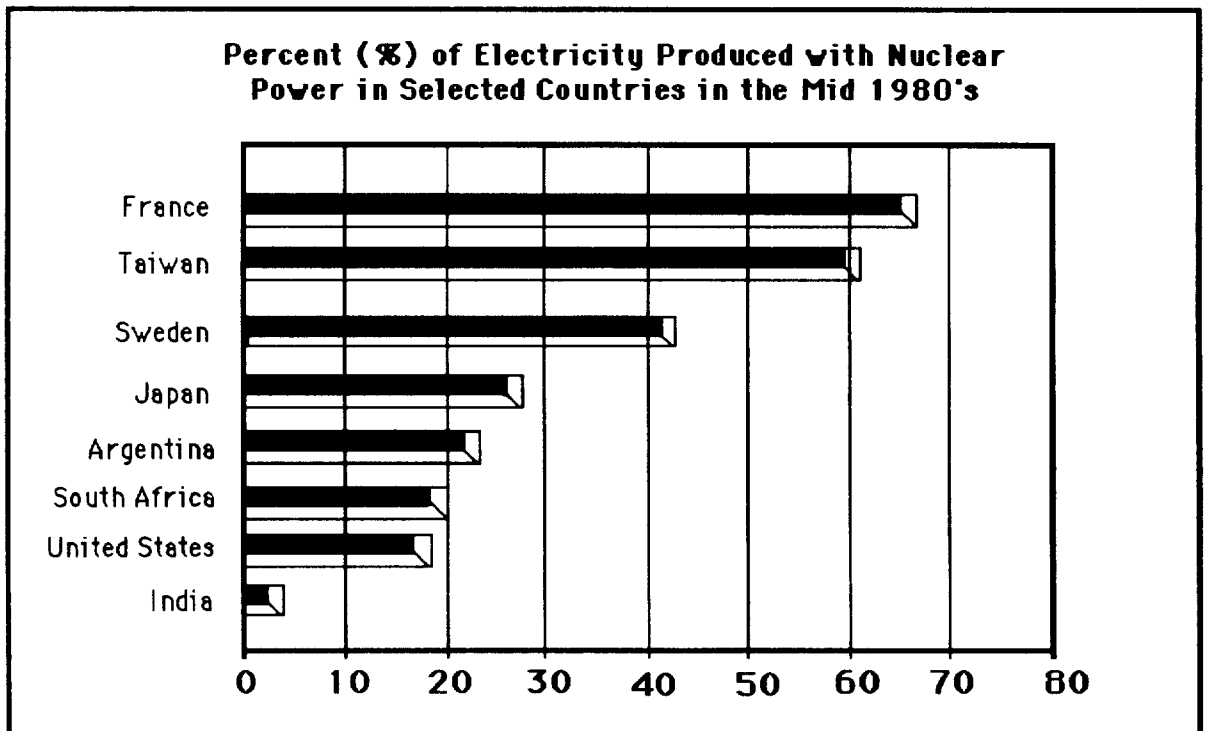
Coal is the second largest fuel source, supplying some 30% of the world's energy. It is also the most abundant fossil fuel, with almost 70% of the world's proven reserves located in the Soviet Union, United States, and China. Coal has seen an increased usage of approximately 4% annually and it is estimated that supplies will last for over 200 years.

## Natural Gas

Over 40% of the world's proven gas reserves are located in the Soviet Union, with a variety of countries containing the rest of the supply. Natural gas usage has increased by almost 5% annually and many regard it as having the greatest potential for growth in the near future, despite one estimated life span of 60-80 years.

## Nuclear Power

Although nuclear power is considered a nonrenewable resource, its estimated potential for energy is greater than that of any of the fossil fuels. However, because of plant mismanagement, poor plant design, and public concerns about safety, nuclear power holds little hope for the near future. In fact, the 5% that this resource now represents in world energy may well drop in the future (Miller, 1991).



## **The Impact of Energy Consumption on the Biosphere**

The primary use of fossil fuels is to produce energy - energy for heat, air conditioning, food preservation, light, and many other aspects of life. One form of energy produced by these fossil fuels is electricity. Between 1960 and 1984, world production of electricity more than tripled.

Currently, most electrical power is generated through the use of coal. Almost 60% of all electric plants in the United States are coal-fired (GTC, 1990). The use of coal to generate electrical power has a serious flaw that reflects a problem with most fossil fuel energy. In producing and transporting electricity, a typical power company loses about two and one-half times more energy than it delivers. In fact twenty-five percent of all energy used in 1985 in the United States was wasted in the production and distribution of electricity (GTC, 1990).

Energy loss is only one aspect of this global change issue. A greater threat to environmental quality is posed by the by-products which result from utilizing fossil fuels for energy production. The following sections describe some of the more harmful by-products and their environmental impacts.

**Smog.** Smog contains ozone and other chemicals which are irritating to the lungs of humans and animals. Smog is produced when sunlight acts on mixtures of nitrogen oxides and hydrocarbons which have been formed through the burning of fossil fuels. Smog is a major health hazard in many cities and also damages crops and forests (GTC, 1990).

**Acid Precipitation.** Acid precipitation (or acid rain) results when sulfur and nitrogen oxides combine with water vapor and become airborne acids. Sulfur oxides and nitrogen oxides are produced primarily via fossil fuel use. Scientists have found that this acid deposition has destroyed large numbers of lakes and forests, and materials such as plastics and stone. This damage to both the biosphere and human-built structures carries a high economic price tag. Sweden, for example, has spent 25 million dollars to neutralize acids in its lakes.

**Oil Spills.** The Exxon Valdez oil spill underscores a critical problem in transporting oil. Every year, between three million and six million metric tons of oil pollute the world's oceans, killing thousands of marine organisms and threatening water quality.

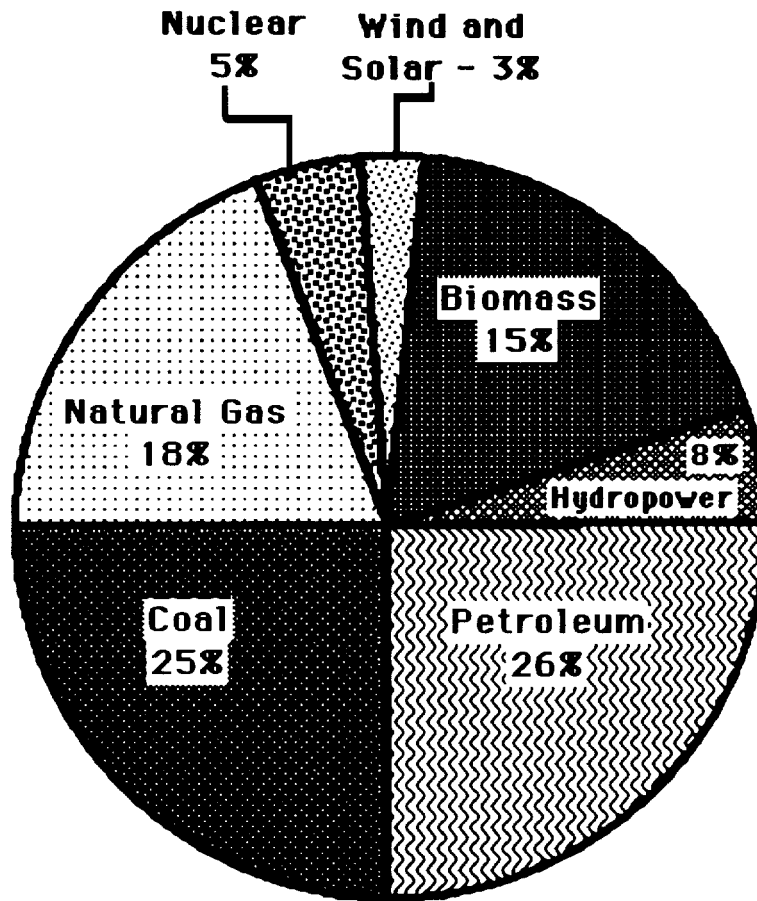
**Global Warming.** As discussed earlier, emissions from fossil fuels have increased the greenhouse gases and, in particular, carbon dioxide. In 1988, fossil fuel burning added about 5.5 billion tons of carbon to the atmosphere.

**Nuclear Radiation.** Perhaps the most noted global disaster of this century, the explosion and fallout from Chernobyl, underscores the potential environmental and social disasters nuclear power is capable of unleashing.

## **The Impact of Energy Consumption on Society**

The production of energy fulfills the needs of billions of the world's inhabitants. In many nations, the use of electricity or gas is a function of societal demands and is seen as not only a way of life but as an important additive to quality of life. Even so, for the many positive effects which this energy brings to the world community, so too are there a variety of social problems.

### World Consumption of Energy in the Year 2000



**Projected world consumption of nonrenewable and renewable energy for the year 2000. The biomass will consist mainly of dung, wood, and crop residues. Biomass and hydropower are both considered to be renewable resources.**

In late 1989, the World Energy Conference concluded that by 2020 the world would be using 75 percent more energy, and that most of this energy would be supplied by fossil fuels (Brown, 1991). Most of these future supplies of fuel will be found in the Middle East. When Iraq invaded Kuwait in 1990, the world faced its third oil shock in 17 years. This resulted in a 170 percent increase in oil prices in three months and led to near panic in world financial markets. This underscores the effect the use of fossil fuels and, in particular, oil has on the security of the world. Although this crisis has been resolved for now, history warns us that the dependency on finite resources does not bode well for world economic and political stability.

Other effects of the use of fossil fuels on society can be directly related to by-products of their conversion into energy. One very important aspect of this is air pollution. The World Watch Institute reported that:

Severe air pollution and its related health problems span continents and levels of development. In the United States, some 150 million people live in areas where the Environmental Protection Agency has declared that the air is unfit. In greater Athens, the number of deaths rises six-fold on heavily polluted days. In Hungary, a recent report by the National Institute of Public Health concluded that every 24th disability and every 17th death is caused by air pollution. In Bombay, breathing the air is equivalent to smoking 10 cigarettes a day. And in Mexico, the capital has been declared a hardship for diplomats because of its unhealthy air; some governments advise women not to have children while posted there. (French, 1990, p. 5)

Since the Industrial Revolution, fossil fuels have provided humans with light, food, transportation, and heat. Ironically, humans have suffered enormous health risks due to the emissions of those same fossil fuels. Listed below are a number of the by-products of generating of energy from fossil fuels along with a description of some of their negative health effects on humans (French, 1990, p. 14).

**Carbon Monoxide:** Interferes with the ability of the blood to absorb oxygen, impairing perception and thinking, slowing reflexes, causing drowsiness, and possibly causing unconsciousness and death; if inhaled by pregnant women, carbon monoxide may threaten the growth and mental development of the fetus.

**Lead:** Affects circulatory, reproductive, nervous, and kidney systems; accumulates in bone and other tissues.

**Nitrogen Dioxide:** Can increase the susceptibility to viral infections such as influenza, irritate the lungs, and cause bronchitis and pneumonia.

**Ozone:** Irritates mucous membranes of respiratory system; causes coughing, choking, impaired lung function; can aggravate chronic heart disease, asthma, and emphysema.

It is difficult to put a dollar estimate on these health effects. One scientist from the University of Wyoming, however, estimates that air pollution costs the United States as much as 40 billion dollars annually in health care and the loss of productivity (French, 1990).

### **Solutions to the Problems of Energy Resource Consumption.**

Up to this point the topic of world energy consumption has been directed toward fossil fuels and nuclear energy. There were several reasons for this. First, it was noted earlier that over 85% of the world's commercial energy comes from these resources and therefore it was prudent to review their status and impact on the world community. Second, virtually all of the global impact of energy consumption comes from the use of these nonrenewable resources.

Still, one important aspect of these resources has yet to be discussed. This is the concept of limited supplies. As discussed previously, reserves of the three major fossil fuels are estimated to last, 200 years or so, at best. Many energy experts advocate a two



pronged effort aimed at future energy options. These include a concerted worldwide effort to conserve fossil fuel, and the development of alternative energy sources.

### **Energy Efficiency**

This term is not completely synonymous with conservation. While this concept does imply a conservation ethic, it is also meant to imply the same or better services with less energy. For example, there is a vast potential for improving energy efficiency on the home front by installing energy efficient appliances, fixtures, and heating/cooling systems, as well as improving home insulation. Swedish households have been using energy efficient strategies for 200 years because of historic fuelwood shortages. Today, homes in Stockholm average six degrees Celsius (6°C) warmer in the winter than houses in London, but use twenty-five percent less energy (Flavin & Durning, 1988).

Our greatest energy resource now and in the future is energy conservation, the reduction or elimination of unnecessary energy use and waste. . . . Using energy conservation to obtain more useful energy has more advantages than any other energy alternative.

G. Tyler Miller, 1988

The industrial sector has made significant gains in energy efficiency. In developed countries, the amount of energy required per unit of industrial production has fallen thirty percent since 1973 (GTC, 1990). Japan has been a leader in this movement by requiring the monitoring of industries for energy efficiency.

Certainly the greatest challenge for energy efficiency is in the arena of transportation. Although considerable progress has been made in producing fuel efficient transportation, transportation is now the largest and most rapidly growing drain on the world's oil supplies (Flavin & Durning, 1988).

While true energy efficiency is a long way off, it does hold great potential. Studies for the World Resources Institute suggest that per capita energy use in industrialized countries could be cut by 50% by the year 2020 (WRI, 1990). Quite simply, energy efficiency makes economic sense. In 1986, for example, the national fuel bill of the United States amounted to 10% of its gross national product. In comparison, the national fuel bill of Japan, with its better record in energy efficiency, amounted to only four percent of its gross national product (Flavin & Durning, 1988). Similarly, improvements in energy efficiency creates more jobs than are created by the production of energy (Brown, 1991).

### **Alternative Energy Sources**

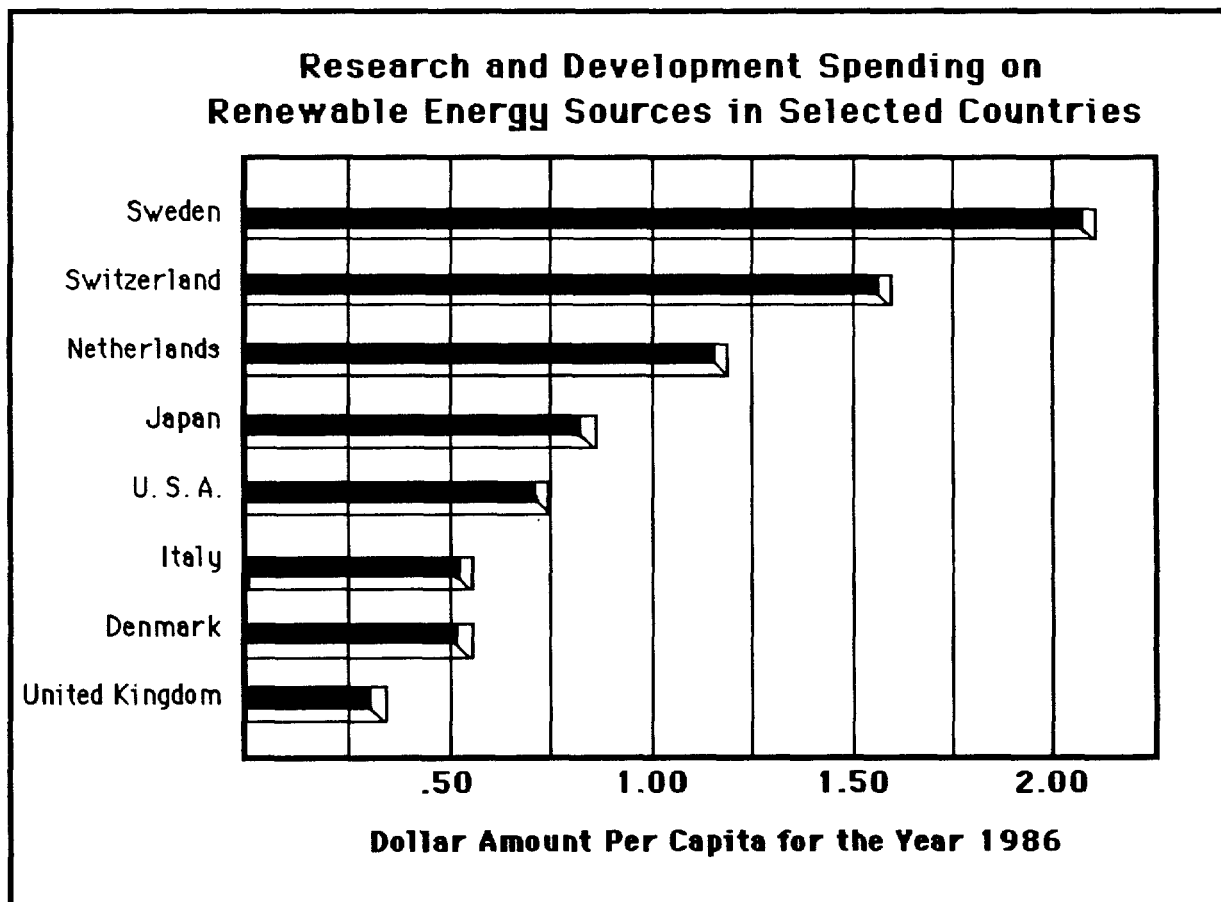
In light of finite fossil resources, it appears prudent to explore alternative forms of energy. Renewable sources of energy, energy from the sun, wind, water, biomass, and the earth itself, could furnish human needs for centuries to come. Developing these untapped resources could meet 50-75% of the world's power needs.

**Solar Power.** "Direct conversion of solar energy will likely be the cornerstone of a sustainable world energy system" (Flavin, & Lenssen, 1990, p. 18). The optimism related to the use of the sun's power stems from the fact that it is probably the most readily available and constant source of energy, and is potentially the cheapest. Today, in Cyprus, Israel, and Jordan solar panels already heat between 25 and 65 percent of the water in homes. More than one million homes in the United States have been built with active solar heating systems. Solar thermal power plants can produce electricity at one third the cost of

that from a nuclear generator. It is estimated that solar thermal plants occupying 1% of the area of the Mojave desert could fulfill the power needs of Los Angeles (Miller, 1991). The advantages of this energy source include its minimal effect on the environment as well as its potential for cheaper energy. Drawbacks of solar energy are its initial costs to upgrade to large scale production and the scarcity of the solar energy in many parts of the world during much of the year.

**Hydro Power.** In 1988, hydro power supplied 21% of the world's electricity and 6% of the world's total energy (Miller, 1991). In some countries, hydro power supplies a substantially greater portion of the energy: Norway - 100%, Switzerland - 74%, and Austria - 67%. Unlike other renewable resources, much of the potential of hydro power has already been developed.

There are, however, regions where further development is possible. For example, Africa has tapped only 5% of its potential, and Latin America and Asia have developed 8% and 9% of their respective potentials. It is projected that new hydro plants in developing countries will produce electricity equal to that of 225 large coal burning power plants (Miller, 1991). As with solar power, hydro energy has relatively little atmospheric impact. These plants, however, are notorious for disrupting river systems and affecting the water quality of watersheds.



**Wind Power.** As of 1990, over 20,000 wind turbines were being utilized worldwide, producing about as much power annually as two nuclear power plants. Most of this power was produced in California, which generates approximately 80 percent of the world's total wind power. Many scientists believe that wind power could supply more than 10% of the world's electricity. Although wind energy creates little environmental impact, the scarcity of a consistent and reliable source of moving air will limit the utilization of this source of power.

**Biomass.** Biomass is organic plant matter, including wood, agricultural wastes, and garbage. Biomass is usually burned to produce energy. In 1988, the burning of biomass supplied about 15% of the world's commercial energy, and was the source of almost 50% of the total energy utilized in developing countries. In areas with a large amount of land to produce biomass, such as Canada and the northern United States, there is an increase in the utilization of biomass for energy production. The use of biomass in developing countries is a different story. Approximately 80% of the people living in developing countries heat their dwellings and cook their food by burning wood or charcoal made from wood. The massive use of these materials for subsistence has produced tragic results. In other words, biomass energy can see successful results in less populated areas while its use in developing, overpopulated, countries can have an enormously negative impact.

... we must begin a global effort to reduce unnecessary waste of matter, energy, and biological resources and shift from nonrenewable fossil and nuclear fuels to renewable energy in the form of essentially inexhaustible supplies of sunlight, wind, flowing water (hydropower), and vegetation (biomass). Efforts to bring about this shift ... are still inadequately supported by governments and taxpayers.

G. Tyler Miller, 1988

**Geothermal Power.** Heat contained in underground rocks and fluids can be an important renewable source of energy. It is economically feasible to utilize geothermal energy when reserves are close enough to the earth's surface to be tapped. Currently, about 20 countries are using this source of energy. The advantage of this source of fuel is its enormous supply when located close enough to the surface. Unfortunately, the major obstruction to using this energy worldwide is its limited access.

### **Barriers to Solutions**

As described above, there appear to be two strategies necessary to resolve the world's energy consumption problems. The first and foremost is to continue to promote and improve energy efficiency programs worldwide. The second strategy is to look more seriously at developing renewable energy resources. The constraints to achieving these goals can be best summed up using an analogy of a drug-addicted individual.

Like an addict, the nations of the world have grown accustomed to an inexpensive supply of drugs - oil, coal, and natural gas. Up until now, that reliance was questioned only when a serious negative side effect became obvious (e.g., the Persian Gulf War, Chernobyl, the Exxon Valdez). When these problems subsided, the world continued to "take its drugs" with a good deal of ambivalence toward energy efficiency and the possibilities of switching to new, healthier alternatives. Certainly, as with all drug addicts, the harm done is far greater than any benefit. Complacency, then, becomes a very real barrier to any long-term solution to the world's energy consumption problem.

**\*\*\*Global Change Issue Vignette\*\*\*  
Household Energy Conservation**

*Improving energy efficiency in the United States using available technologies will produce over three times as much energy by 2020 at a lower cost than finding and developing . . . all new natural gas deposits believed to exist in the United States.*

G. Tyler Miller, 1991

The United States of America is by far the largest energy user and waster in the world. The U.S. has more impact on fossil fuel consumption, oil pollution, acid deposition and other forms of air pollution than any other country. Moreover, at least 43% of all energy used in the United States is wasted (Miller, 1991). There are, fortunately, success stories that reflect another image of a more prudent and conservation-minded nation.

In a rural setting of North Carolina, Evan and Peggy Kruppenbach live in a modest house surrounded by lush forestlands. The Kruppenbachs live in a household that epitomizes energy conservation. The building is filled with a variety of energy saving additions that have made the house a model of conservation. Some of the highlights of the Kruppenbach's home are described below.

A solar room includes a solar collector with double-paned conventional glass windows. Thick concrete floors and filled concrete blocks face the sun and slowly absorb heat. The room collects enough solar energy to meet about 60% of the space heating needs during the cold months. The rest of the heat is provided by a small wood stove.

The Kruppenbachs utilize an "earth air conditioning" system. Four plastic pipes are buried underground and extend down a hillside. One end of each tube comes up through the foundations of the house where it connects with the air duct system and an electric fan. When the fan is on, it draws the air in at the bottom of the hill. The air becomes cooled while passing through the underground pipes. The Kruppenbach's also have implemented a number of strategies to conserve water. Among these strategies are water-saving faucets, water-saving showerheads, and a low-flush toilet.

The house has a heavily insulated refrigerator that runs on liquefied petroleum gas. It also has an active solar hot water heater, which at times can be used to heat the house. The light bulbs are fluorescent and use about 60% less energy than conventional bulbs. The installation and use of these energy saving strategies have seen benefits which are both environmental and economical. Present electricity bills run around \$30 a month, compared with \$100 or more for conventional structures of the same size. The earth air conditioning costs about \$1 per summer.

Many of the energy conservation measures in the Kruppenbach home were inexpensive to install, with long term economic benefits in the form of energy savings. This couple is representative of thousands of other home owners who have begun to conserve energy. It is this type of individual action which will be an important solution to conserving our depleting energy resources.

## Global Land Use

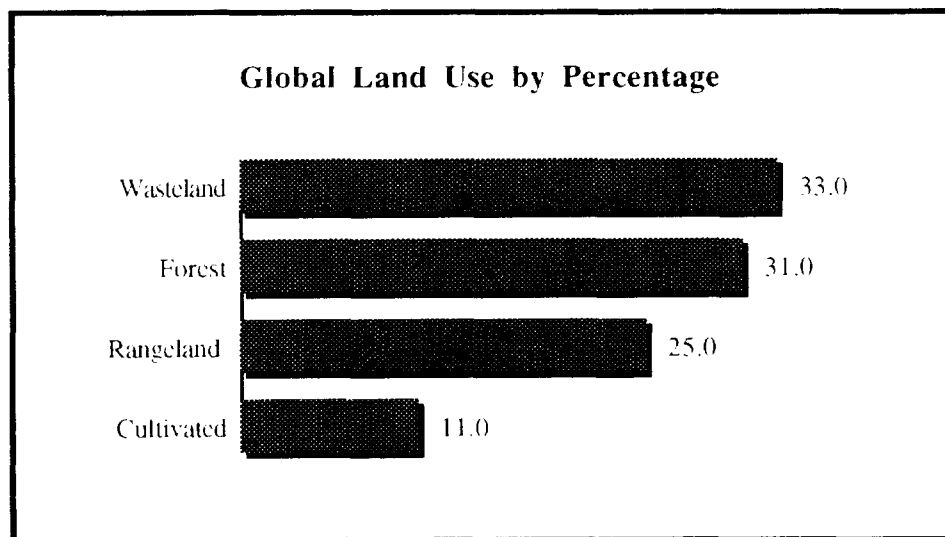
*"A drought is a lack of water, but not necessarily a disaster. Whether or not a drought becomes a disaster depends on how people have been managing their land before the drought. . . . Given the overcultivation and land misuse forced on many people in the tropical Third World, one would expect drought to be a major disaster worldwide. It is."*

*Lloyd Timberlake, Africa in Crisis, 1985.*

The biosphere is made up of three major systems: the hydrosphere, the atmosphere and the lithosphere. The crustal layer of the lithosphere is a thin layer of land upon which humans subsist. This layer covers roughly one-third of the surface of the planet and supports forests, grasslands, and croplands. In turn, forests, grasslands and croplands supply a large portion of the resources utilized by humans and represent a substantial proportion of the world's economic basis.

Forests are sources of fuel, lumber, paper, and a variety of other social and economic products. Grasslands support the production of meat, milk, leather, and wool. Croplands are the basis for food supplies, feed for livestock, and the raw material for textiles and an array of industrial products. Since the beginning of human existence, control and use of the earth's land has been an essential aspect of survival. The rapid growth of both human population and human consumption has increased the variety of these uses and the severity of the impact of their usage.

There are approximately 13 billion hectares of land on the earth. According to the United Nations Food and Agriculture Organization (Brown, 1990, p.5), 31% of this land is forested, 25% is utilized as rangeland, and 11% is in cultivation (see table below). Thirty-three per cent of the total acreage is classified as "wasteland", land that supports little biological activity, (i.e., desert, or land which has been built upon or paved over).



The actual amount of land which can be utilized by the world community is shrinking. The amount of acreage which is in forests, crops, or ranges has decreased, while the portion of the earth considered wasteland has increased (Brown, 1991). The source of this loss of usable land is termed "land degradation". Land degradation will be defined here as a loss of land productivity through various human interactions. In 1984, the United Nations estimated that 35% of the land surface of the earth was in peril due to land degradation. Moreover, it appears that approximately six million hectares of land, annually, are destroyed due to degradation (Bojo, 1991).

"Cattle play a prominent role in global desertification - the reduction of dryland's ecological productivity."  
(Durning & Brough, 1991)

### The Causes of Land Degradation

There are four primary causes of land degradation: overgrazing, overcultivation, salinization of farmland, and deforestation. Livestock grazing, agricultural overcultivation and timbering - all interactions between humans and the environment - have helped sustain societies for thousands of years. Unfortunately, these activities have also depleted the soil of nutrients and have rendered millions of hectares of land useless for subsistence.

**Overgrazing.** Cattle and other livestock graze approximately half of the planet's arable land. Heavy grazing by livestock can lead to a rapid decrease in nutrient stability, thereby decreasing the chances of further growth of vegetation. Subsequently, the loss of plant cover promotes the aridity of the soil and increases the likelihood of desert-like conditions. Many developing and developed countries have witnessed this transformation. In fact, the United Nations Environment Program estimates that 73 percent of the world's 3.3 billion hectares of dry rangeland is at least moderately desertified (Durning & Brough, 1991).

**Overcultivation.** The primary cause of this type of degradation is farming practices that allow soil depletion and erosion. An inch of top soil takes anywhere from 200 to 1,000 years to form. However, agricultural land that is left without any vegetative cover or which is over-cultivated can lose an inch of soil in a handful of years. The world's farmers lose an estimated 24 billion tons of topsoil a year (Brown, 1990). The loss of topsoil and the degradation of farmlands is a problem in both developing and developed countries. In fact, the United States has a higher rate of soil erosion per hectare of cultivated land than does Peru (GTC, 1990).

"The degradation of agricultural land is the most widespread threat to habitat worldwide"  
(Jacobson, 1988)

**Salinization of Farmland.** A third source of land degradation is the salinization of croplands. The primary cause of salinization is the over-irrigation of farmland. Excess water tends to "sit" on the irrigated soil. As it evaporates, it leaves a layer of salt that is toxic to plants. The United Nations Environmental Programme has estimated that, as of 1989, forty million hectares of farmland had been degraded by salinization (Brown, 1989).

**Deforestation.** The final major cause of land degradation is deforestation. When tracts of forest are cleared without proper revegetation practices, the soil becomes depleted of its nutrients. This process of degradation is illustrated most dramatically in sensitive tropical rainforests. The United Nations Food and Agricultural Organization estimates that each year 11.3 million hectares of rainforests are cleared, leaving vast areas of land ripe for desertification (Brown, 1989).

There appear to be three major contributions by society to land degradation. The first is the exponential growth of world population and a concomitant increase of land usage. The human community is critically affecting the carrying capacity of the earth with regards to its land resources. In examining this problem, the World Bank commissioned a study on the carrying capacity of several developing countries. They found that in most cases, the rural population had already exceeded the food production capabilities, and that wood resources were virtually nonexistent (Brown, 1989).

A second societal influence on land degradation is the uneven distribution of land ownership. In most countries, a minority of individuals own a majority of the land. Millions are left to subsist on smaller and less productive land tracts, causing land degradation at a faster pace. For example, in countries such as the Philippines, Thailand, and South Africa, wealthy citizens hold most of the fertile land, while a majority of the citizens are left to subsist on mountainsides, swamps, and arid lands.

A final cause of land degradation is governmental policy that promotes unsustainable land use. One example of such a policy is Brazil's relocation program which has spelled disaster for millions of acres of rainforests.

### **Impact of Land Degradation on the Biosphere**

One outcome of land degradation is soil erosion. When soil is eroded from the land, it will more than likely become runoff that is washed into watersheds. In China, for example, the Yellow River carries more than a billion tons of sediment to the sea annually. This input of sediments increases the turbidity of water causing tremendous damage to the quality and biodiversity of watersheds.

Land degradation may influence the hydrologic cycle as well. There is serious speculation among members of the scientific community that loss of vegetation and exposure of soils to the atmosphere actually create warmer and drier regional climates. For example, it appears that desertification of the Sahel region of Africa may have contributed to a decrease in rainfall, and to the resulting drought conditions in that area. Studies in the Sahel indicate that the increase in insolation due to greater exposure of the soil, raises temperatures and decreases the potential for moisture entering back into the atmosphere. Further examples of this meteorological effect are evident in India and Brazil (Brown, 1989).

### **The Impact of Land Degradation on Society**

The deterioration of productive land frequently leads to the deterioration of economic stability. A 1990 international study indicated that the cost of land destruction due to salinity is approximately 51 million dollars a year (Bojo, 1991). In global terms, the United Nations Environmental Programme estimates that monetary loss attributed to lost production from degraded lands ( i.e., irrigated lands, range lands, rain-fed croplands), would add up to 26 thousand million dollars annually (Bojo, 1991). This figure, although difficult to substantiate, is representative of the cost born by society when land deteriorates.

"What appear, then, to be consequences and signs of meteorological drought - withered crops, falling groundwater levels, and dry stream beds - can actually be caused as much or more by land degradation."  
(Brown, 1989)

In many of the developing countries, land degradation is directly related to personal poverty. The millions of subsistence farmers who degrade the land for survival are victims

"Throughout the Third World, land degradation has been the main factor in the migration of subsistence farmers into the slums and shanty-towns of major cities, producing desperate populations vulnerable to disease and natural disasters."  
(Jacobson, 1988)

of their own impact. The depletion of the land results in one of the most tragic societal /environmental scenarios in modern time, human migration.

Approximately 135 million people inhabit areas experiencing degradation. Scientists from Texas Tech University speculate that "50 million have already experienced a major loss in their ability to support themselves and an unknown percentage will have to abandon their agricultural way of life". (Jacobson, 1988, p. 12). No other region of the world experiences this tragedy more than Africa and, in particular, the Sahel. Land degradation, along with political instability, has

caused millions of farmers to migrate to cities. In the last twenty years, the urban population has quadrupled. Many who could not migrate, perished. It is estimated that nearly 200,000 thousand people have died as a result of this land degradation.

It appears that population pressures from both humans and livestock have influenced migratory patterns in Kenya. The Kenya Agricultural Research Institute concluded that increased human and livestock population has raised the pressure on the land in the semi-arid regions of Kenya. This has severely restricted the movement of the country's pastoralists and has forced many of these tribes to alter their patterns of subsistence (Potter & Said, 1986).

### **Solutions to Land Degradation**

Land degradation is a clear and present threat to both the survival of millions of people and the stability of the biosphere. Therefore, solutions to this issue are critical and urgent. As with tropical deforestation, a key to the solution of land degradation is sustainable use. A sustainable use policy is one based on long range planning and the recognition that to maintain and "cultivate" our world resources we must recognize the limits of these resources. Simple techniques of soil and water conservation can certainly be important aspects of sustainable practices. Below are three examples of such practices utilized in developing countries. (Brown, 1989)

- Mulch application - In Nigeria, mulch of crop residue is applied to slopes of farmlands. The mulch protects the soil from the impact of raindrops, increases rainfall infiltration, and conserves water. The International Institute of Tropical Agriculture has found that this method has increased crop yields and has sustained soil resources.
- Alley cropping - This method of planting utilizes an agroforestry design in which crops are planted in "alleys" between trees or shrubs. The fallen foliage of the trees provides a good mulch. Additionally, when this method of planting is used on sloping ground, both runoff from rainfall and soil erosion are reduced.
- Vetiver grass - This densely tufted, deep rooted plant is native to India, and is an inexpensive alternative to other erosion measures. It survives in all climates and can form continuous hedges along hillsides which slow runoff and trap sediments to produce higher crop yields.



Additional strategies to promote sustainable agriculture have been suggested by a research from the Banaras Hindu University in India (Rai, 1990). Among these is the integrated use of plant nutrients to enhance the moisture-holding capacity of the soil. The introduction of new crops in non-conventional areas could be also useful in enhancing food production and decreasing soil degradation. For example, the high yielding varieties of soybean and mustard now being grown in northern India might be introduced in the south to promote sustainable farming in that region (Rai, 1990).

### **China's Eco-Farming**

China's eco-farming industry is a comprehensive agricultural production model based on a multi-purpose management system. It is marked by the following features:

- A focus on crop rotation, inter-planting, and the use of organic fertilizer.
- An attempt to utilize solar energy and windmills for irrigation.
- The "recycling" of as much farm wastes as possible to use in future crop production.

These farming practices are expanding to the point where the Chinese government is including eco-farming products into its major development program. (Qi, 1991)

Land reform appears to be another solution to land degradation. Land reform involves giving the landless rural people ownership of enough arable land upon which to subsist. It is postulated that the sense of ownership of the land promotes a stewardship ethic. As mentioned earlier, the world's distribution of land is disproportionate. For example, in Brazil, 2% of the landowners control 60% of all the arable land (WRI, 1990). The objective of land reform is to promote individual stewardship of the land and, in turn, to decrease the potential for large scale land degradation. It is also hoped that land reform would encourage an attachment to the land which would discourage large human migrations.

Although the intended outcomes of this strategy are positive toward decreasing land degradation, its implementation has been met with mixed success. Land reform efforts have been initiated in many Andean countries, only to be cut back or reversed due to a lack of management and political instability. In contrast, Taiwan has experienced a measure of success with small owner-operated farms, which out-produce large sugar plantations in the Philippines (Brough, 1991).

### **Barriers to Solutions**

"The struggle against desertification has failed to produce satisfactory results. There is very little written evidence of successful programs and sizable projects. Most evaluations and comments on conservation policies indicate failure." (Bojo, 1991, p.78)

As is the case with other global change issues, attempting to remediate land degradation demands addressing more than just environmental implications. The problems and issues pertaining to world land degradation transcend cultural, political, and economic boundaries. For example, the inability of land reform to achieve large scale success is due in part to the economic benefits from large scale grazing and farming. Individual land owners have a difficult time competing, economically and politically, with those already in possession of large amounts of land.

Much of the success of land reform is dependent on sustainable development. The concept of sustainable development reflects a broad approach to land use that relies on changes in personal lifestyles as well on implementing national and international regulations. These characteristics associated with sustainable development require a great deal of financial and governmental support. Unfortunately, neither have been sufficient to see large scale success.

**Every day, 3500 acres of rural America are bulldozed to make way for new buildings and highways.**

**American Demographics in World Watch, 1990**

**\*\*\*Global Change Issue Vignette\*\*\***  
**The Ngisonyoka Herders and Land Use Management**

*Livestock management practices of East African pastoralists do not degrade the environment....and successfully function to cope with environmental problems.*

J. Terrence McCabe, 1990

In Africa, it has been estimated that between 25-30 million people depend on livestock as their major source of food and money (McCabe, 1990). During the last several decades there has been considerable debate pertaining to the use (or misuse) of grazing land and to the ability of indigenous peoples to manage rangeland.

One tribal group that has been studied in relation to its impact on the land is the Ngisonyoka people who live in northwestern Kenya. This tribe, which numbers approximately 10,000 individuals, occupies 10,000 sq km of desert and arid to semi-arid rangelands. Its land consists of sand and lava plains, interrupted with mountains rising 2,000 to 3,000 meters. Precipitation averages approximately 220 mm per year, but is highly unpredictable. It is a land where drought is common.

The Ngisonyoka subsist in this harsh environment by managing domestic livestock: camels, cattle, sheep, goats, and donkeys. They practice no agriculture and live completely off the herds. These people are highly mobile with no fixed residences nor regular pattern of movement. An important aspect of their culture is that no individual rights to forage resources exist. Every Ngisonyoka herd-owner has the right to exploit any pasture within the region's territorial boundary.

During the early 1980's, a group of researchers studied the relationship of the Ngisonyoka and the land on which they they subsist. The South Turkana Ecosystem Project (STEP), conducted exhaustive investigations to learn whether or not this tribe was negatively impacting the land. Results of the six year study concluded that: 1) the Ngisonyoka subsistence incorporates complex ecological practises which promote long term stability of the rangeland; 2) the range that the tribe uses is stocked well below its carrying capacity, which again promotes a stable rangeland; and 3) there was no evidence of environmental degradation to the range area.

The research group also found that the Ngisonyoka had in place social institutions to cope with environmental problems. For example, individual families are protected by norms that facilitate livestock exchange, and resources are also protected by the identification and defense of territorial boundaries. STEP also pointed out that these pastoral people do not sacrifice long-term stability for short-term gain at the expense of the environment. The findings of this study disagree with the critics who believe that the pastoral people are responsible for widespread land degradation. As World Watch Institute comments, "It's a matter of culture. Tribes that developed over thousands of years could only thrive by encoding ecological sustainability into the body of practice, myth, and taboo that passes from generation to generation." (Durning, 1989, p.11)

## PART III

### Strategies for Involving Learners in Global Change Issue Instruction

*Our species is now at its most important turning point since the Agricultural Revolution. Sustaining the earth means that each of us must change our individual consumption habits and lifestyles to reduce our environmental impact.*

*G. Tyler Miller, 1991*

#### Introduction

Becoming aware of the variables associated with global change is an important step in educating students about the earth's environment. This, however, is only the first aspect of environmental education and of global change education. Global change education should be centered on global change issues and alternative solutions . . . their identification, analysis, evaluation, and remediation.

Research suggests that encouraging human behavior change, on an internalized and lifelong basis, necessitates focusing the learner on real-life problems and issues. Global change issues which could provide this focus would include (but certainly not be limited to) human population growth, land-use management, deforestation, and energy resource management. Such a focus would also include the development of the independent critical thinking skills which influence responsible decision-making (Hungerford et al, 1989).

**A major goal . . . is to develop a human being who can contribute to the solution of global environmental issues.**

A major goal for environmental education and thus, for global change education) is to develop a human being who can become an effective citizen in the world community and who can contribute to the solution of (global) environmental issues. This goal demands a number of prerequisite skills. These skills include: the ability to identify global environmental

issues, the ability to analyze issues and correctly identify individuals or groups involved in an issue, the ability to investigate issues in a manner as to identify the facts surrounding them and their proposed solutions, the ability to evaluate issues and to determine the most effective means of resolving them, the ability to develop an action plan which can be implemented in an attempt to resolve a particular issue, and the ability to execute an action plan consistent with his/her personal values.

#### Responsible Environmental Behavior

The ultimate aim of education is shaping human behavior. Societies throughout the world establish educational systems in order to develop citizens who will behave in desir-

able ways. In education, some of the desired behaviors are sharply defined, e.g., skills useful in reading and mathematics. Other desired behaviors are more complex, e.g., successful consumerism, productive employment, responsible citizenship. It is on one of these latter behaviors, responsible citizenship, that this section of the document is focused. Specifically, this part will address the effectiveness of environmental education for promoting responsible citizenship behavior.

We speak in adamant and emotional terms about somehow salvaging a quality environment and a substantial quality of life for human beings. And yet, at the same time, we fail to change our behaviors in a manner which would permit these things to happen. Thus, it is imperative for us to somehow escape the terribly egocentric boundaries which define our personal and cultural demands for resource consumption and degradation. There is absolutely no way that increasing human populations and decreasing environmental integrity can result in anything but disaster for the human race and environmental support systems.

How might responsible environmental behavior be operationalized? In order to answer this question, we must look to the objectives for environmental education (EE) as defined by the 1977 Tbilisi Intergovernmental Conference on Environmental Education. These objectives, which can be found in the Tbilisi Declaration (1978), are:

*Awareness:* to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems [and/or issues]. \*

*Sensitivity:* to help social groups and individuals gain a variety of experiences in, and acquire a basic understanding of, the environment and its associated problems [and/or issues].

*Attitudes:* to help social groups and individuals acquire a set of values and feelings of concern for the environment and motivation for actively participating in environmental improvement and protection.

*Skills:* to help social groups and individuals acquire skills for identifying and solving environmental problems [and/or issues].

*Participation:* to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems [and/or issues].

By using these objectives, we might define an environmentally responsible citizen as one who has: (1) an awareness and sensitivity to the total environment and its allied problems [and/or issues], (2) a basic understanding of the environment and its allied problems [and/or issues], (3) feelings of concern for the environment and motivation for actively participating in environmental improvement and protection, (4) skills for identify-

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\* - The writers believe that the terms "problems" and "issues" should be used differently. Although some writers use these terms synonymously, distinguishing between them helps learners to conceptualize them differently. An environmental "problem" exists when something is at risk, for example, a new power plant emits too many pollutants. An environmental "issue" exists when human beings have differing beliefs and values concerning what should be done about the problem, for example, people may differ in their beliefs about what should be done about the power plants emissions. Thus, an issue is born.

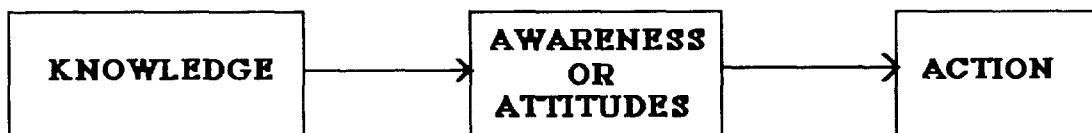
ing and solving environmental problems [and/or issues], and (5) active involvement at all levels in working toward resolution of environmental problems [and/or issues].

The task which is implied by the Tbilisi Objectives is an ambitious one. The citizenship behavior which they describe demands an educational thrust which goes beyond traditional practices in education. Instead, we are faced with a set of objectives which paint a broad picture of behavior encompassing not only knowledge, attitudes, and skills, but also active participation in society. The challenge for educators is to translate the Tbilisi Objectives into instructional reality. And, since the objectives focus on responsible behavior, it would be appropriate and helpful to consult traditional thinking about behavior as well as research into environmental behavior.

**The challenge for educators is to translate the Tbilisi Objectives into instructional reality.**

### **Traditional Thinking Vs. Research Findings**

The traditional thinking in the field of environmental education has been that we can change behavior by making human beings more knowledgeable about the environment and its associated issues. This thinking has largely been linked to the assumption that, if we make human beings more knowledgeable they will, in turn, become more aware of the environment and its problems and, thus, be more motivated to act toward the environment in more responsible ways. Other traditional thinking has linked knowledge to attitudes to behavior. An early and widely accepted model for EE has been described in the following manner: "[I]ncreased knowledge leads to favorable attitudes . . . which in turn lead to action promoting better environmental quality" (Ramsey & Rickson, 1977). Both of these models are, in fact, very similar and can be illustrated in the following manner:



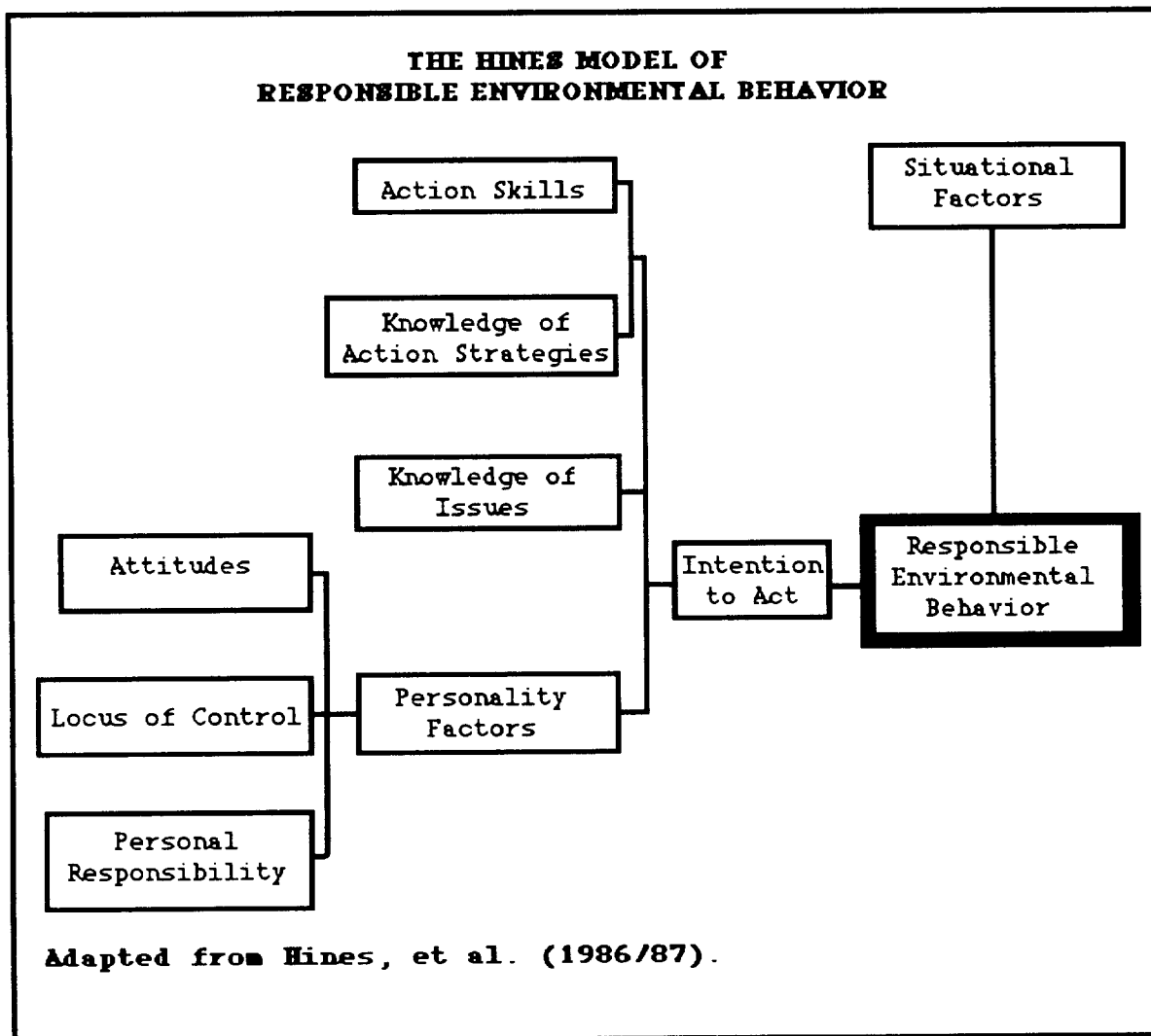
Research into environmental behavior, unfortunately, does not bear out the validity of these linear models for changing behavior. Numerous researchers have investigated a variety of variables hypothesized to be associated with responsible environmental behavior. Many studies have looked at only one variable at a time and numerous of these have been correlational studies which cannot claim "cause and effect" relationships.

This is not to say that the research in the field has not been productive. Indeed, it has. However, to present a detailed survey of the research literature here would be an enormous task and detract from the thrust of this document. Let us, at least initially, transcend the bulk of that research by focusing our attention on one particular study which synthesized the work that preceded it.

In 1986/87, Hines, et al. published an important meta-analysis of the behavior research literature in EE. The researchers analyzed 128 studies

. . . which had been reported since 1971 . . . which assessed variables in association with responsible environmental behavior and which reported empirical data on this relationship. . . . An analysis of data [from these studies] resulted in the emergence of a number of major categories of variables which had been investigated in association with responsible environmental behavior. . . . In the end, fifteen separate variables were meta-analyzed in an effort to determine the strength of their association with environmental behavior.

From this scientific analysis, a model of responsible environmental behavior emerged. This model is displayed below.



In discussing this model, Hines, et al. made the following inferences:

An individual who expresses an intention to take action will be more likely to engage in the action than will an individual who expresses no such intention. . . . However, . . . it appears that intention to act is merely an artifact of a number of other variables acting in combination (e.g., cognitive knowledge, cognitive skills, and personality factors).

Before an individual can intentionally act on a particular environmental problem, that individual must be cognizant of the existence of the [issue]. Thus, knowledge of the [issue] appears to be a prerequisite to action.

[A]n individual must also possess knowledge of those courses of action which are available and which will be most effective in a given situation.

Another critical component . . . is skill in appropriately applying this knowledge [i.e., knowledge of action strategies] to a given [issue].

In addition, an individual must possess a desire to act. One's desire to act appears to be affected by a host of personality factors. . . . locus of control, attitudes [toward the environment and toward taking action], and personal responsibility [toward the environment].

Situational factors, such as economic constraints, social pressures and opportunities to choose different actions may . . . serve to either counteract or to strengthen the variables in the model.

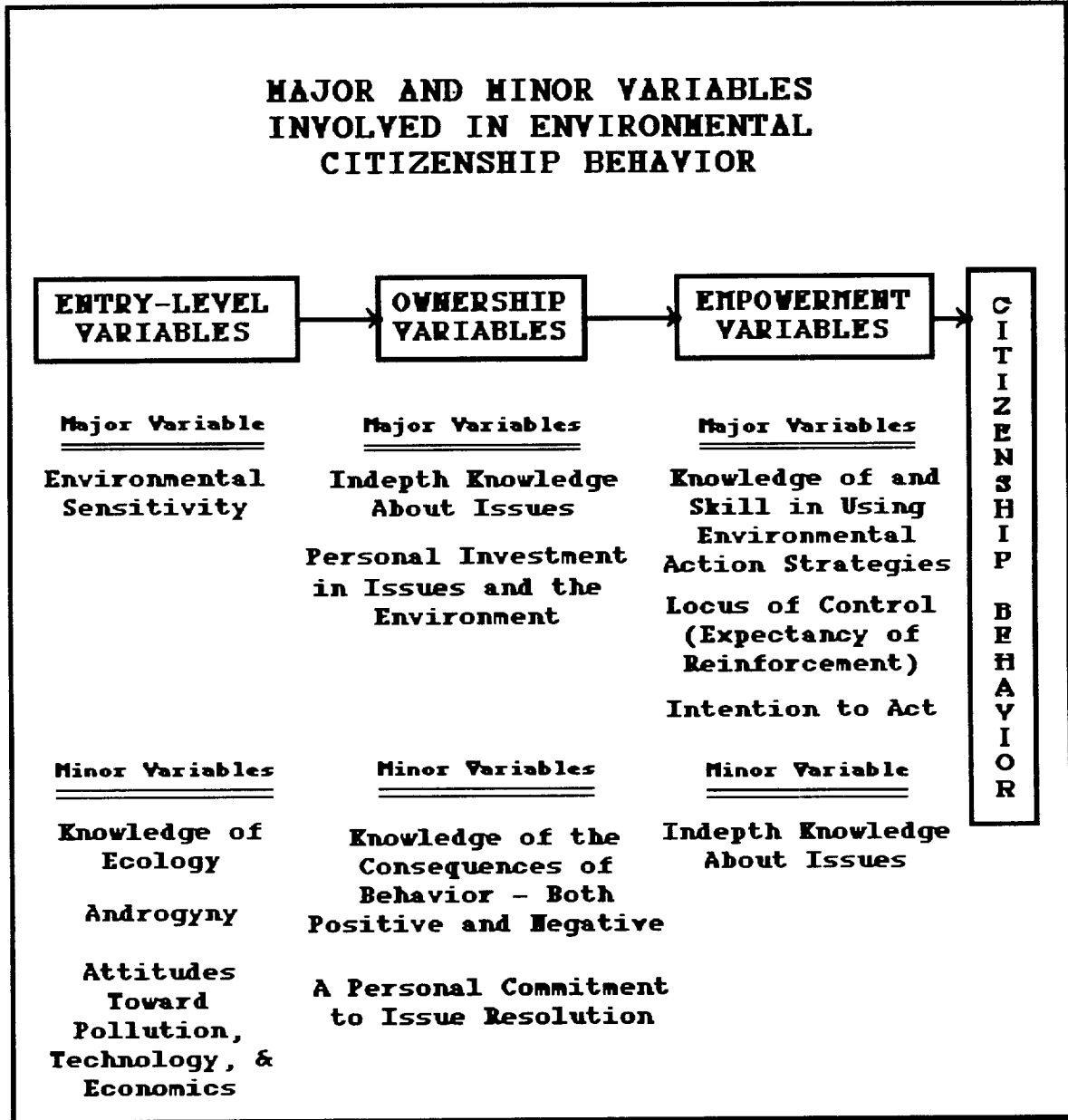
### **An Evolution of the Behavior Model**

Concurrently with or subsequent to the Hines, et al. research, a number of other researchers were making substantial contributions to the literature on behavior (Borden 1984/85; Borden & Powell, 1983; Holt, 1988; Koslowsky et al., 1988; Marcinkowski, 1989; Ramsey 1989; Sia et al, 1985/86; Simpson, 1989; Sivek, 1989).) Some of this research focused on the precursors (predictors) of behavior and some on the outcomes observed from instructional strategies which incorporated a number of the variables from the Hines, et al. model.

These studies, coupled with the Hines, et al. model revealed that there are probably three categories of variables that contribute to behavior. The variable categories (entry-level variables, ownership variables, and empowerment variables) are hypothesized to act in more or less of a linear fashion, albeit a complex one. These variables are displayed as a Behavior Flow Chart.



Behavior Flow Chart



**A Brief Discussion of the Variables Described in the Behavior Flow Chart**

In the discussion that follows, an attempt is made to describe the variables listed in the Behavior Flow Chart. At certain points, comments are made about the synergistic relationship that appears to exist between certain, closely related variables. The reader is cautioned to keep in mind that *all* of the variables discussed below probably operate in some sort of synergistic manner. While the *categories of variables* probably operate in a linear fashion, the *variables within each category* do not necessarily operate in a similar manner. It should also be noted that more research is needed to fully understand the relationships between these variables and behavior.

## **Entry-Level Variables**

Entry-level variables are good predictors of behavior, or ones which appear to be related to responsible citizenship behavior. These appear to be prerequisite variables or, at the very least, variables that would enhance a person's decision-making, once an action is undertaken. These variables will be briefly introduced here. Subsequently, several will be discussed in more detail.

**Environmental sensitivity** is defined as an empathetic perspective toward the environment. It is the one entry-level variable that has shown a dramatic relationship to behavior in the research. Given these data, considerable attention must be given by environmental educators to this variable.

**Androgyny** [in a psychological sense] is a variable which is often associated with individuals who are active in helping resolve environmental issues. Androgyny refers to those human beings who tend to reflect non-traditional sex-role characteristics. For example, an androgynous male may be a very sympathetic individual and able to cry in a sad situation (a traditional female characteristic). An androgynous female, for example, may exhibit certain male characteristics such as assertive behavior. Androgyny is not as strong a predictor as environmental sensitivity.

**Knowledge of ecology** is listed here because it is almost always prerequisite to sound decisions regarding solutions to issues. "Knowledge of ecology" refers to an ecological conceptual basis for decision-making, e.g., concepts associated with population dynamics, nutrient cycling, succession, homeostasis, etc. The research would indicate that knowledge of ecology does not, in itself, produce environmental behavior. Still, it is an important variable when one considers the importance of ecological concepts in decision-making.

**Attitudes toward pollution/technology/economics** are variables that have shown themselves to be significant in some of the research. Although these attitudes appear to be involved with behavior, the extent of their involvement is still unknown and, thus, they are shown here as minor variables.

## **Ownership Variables**

Ownership variables are those that make environmental issues very personal. The individual "owns" the issues, i.e., the issues are extremely important, at a personal level, to him/her. Much of what we know about "ownership" is inferred from a variety of studies. Ownership variables appear to be critical to responsible environmental behavior.

**Indepth knowledge** (understanding) of issues appears crucial to ownership. A number of important studies have addressed this variable. It appears that, before individuals can engage in responsible behavior, they must understand the nature of the issue and its ecological and human implications. When individuals have an indepth understanding of issues, they appear more inclined to take on citizenship responsibility toward those issues.

**Ownership variables make environmental issues very personal.**

**Personal investment** in an issue or an action is another variable that we hypothesize to be a major factor in this category. Personal investment is much like "ownership" itself. Here the individual identifies strongly with the issue because he/she has what might be called a proprietary interest in it. For example, an individual who thoroughly understands the economics of recycling and who uses a substantial amount of recyclable material might feel a substantial personal economic investment in recycling. However, the motivation might not necessarily have to be economic. It could be environmental in nature if the person has good ecological concepts about waste disposal, biodegradability and nutrient cycles and understands the broad human involvement in these things. Recycling might, then, become a strong personal need which could be translated as "personal investment".

### **Empowerment Variables**

Empowerment variables are crucial in the training of responsible citizens in the environmental dimension. These variables give human beings a sense that they can make changes and help resolve important environmental issues. "Empowerment" seems to be the cornerstone of training in environmental education. Unfortunately, it is a step that is often neglected in educational practice. A discussion of "empowerment variables" follows.

**Perceived skill in using environmental action strategies** is one of the very best predictors of behavior. Simply put, perceived skill in using action strategies can

**Perceived skill in using environmental action strategies is one of the very best predictors of [environmental] behavior.**

be translated as human beings believing that they have the "power" to use citizenship strategies to help resolve issues. Further, these skills are fairly easy to teach to learners. Teachers trained in this strategy report that students tend to develop a great deal of self-confidence as a result of this training. Training in action skills also results in improved students' self-concepts and a

belief that they have been more fully incorporated into society. These are very powerful considerations when the aim is to make students more responsible citizens in their own communities.

**Knowledge of environmental action strategies** is a variable that sometimes shows a relationship to behavior in the research. The extent to which this variable is separate and apart from "perceived skill in using action strategies" is unknown. It is probable that the skill component is dependent on the knowledge variable to a great extent. Knowledge *about* action strategies per se is not as powerful a predictor as the skill variable. This explains why these two variables are listed together in the Behavior Flow Chart.

A word of caution may be necessary here. In the studies which examined behavior, learners gained an indepth knowledge of issues as well as learning about action strategies. It is suspected that these two major variables operate synergistically, not separately. Thus, it would appear unlikely that citizenship action skills taught without issue-related knowledge would prompt responsible behavior in individuals.

**Locus of control**, although not as good a predictor as perceived skill in using action strategies, is important also. And, like many of the other variables discussed here, this one is probably interconnected with others.

Locus of control refers to an individual's belief in being reinforced for a certain behavior. A person with an "internal locus of control" expects that he/she will experience

success or somehow be reinforced for doing something. Success, in turn, appears to strengthen his/her internal locus of control. On the other hand, a person with an "external locus of control" does not believe that he/she will be reinforced for doing something and, therefore, probably will not do it.

An individual who believes that he/she has good fishing skills is more likely to attempt fishing because there is an expectation of success or reinforcement for this behavior. This person has an internal locus of control for fishing. An individual who believes that he/she is powerless to make changes in society will probably not act in a citizenship dimension. There is no expectation of success or reinforcement for acting. This person would have an external locus of control for trying to help resolve environmental issues. An internal locus of control probably cannot be developed *directly* in the classroom. However, there is research that indicates that locus of control can be improved as a consequence of teaching citizenship action skills. An improved locus of control may well result when students have had an opportunity to apply these skills successfully in the community.

**"Empowerment" seems to be the cornerstone of training in environmental education.**

**Intention to act** seems also related to the "empowerment" variable. If a person intends to take some sort of action, the chances of that occurring are increased. It is likely that this variable is closely related to both perceived skill in taking action and locus of control. "Intention to act" may also share a synergistic relationship with "personal investment", which was discussed earlier under the "ownership" heading.

### **Goals and Objectives for Instruction in Environmental Education**

Behavior in the environmental dimension can be thought of as so very complicated as to make instructional planning difficult. This difficulty (as well as a lack of research into the precursors of behavior and instructional strategies designed to change behavior) probably resulted in the assumption that knowledge leads to awareness which leads to behavior, i.e., the knowledge > awareness > behavior model.

There has been a great deal of criticism about the lack of direction in EE over the past fifteen years. The lack of emphasis upon objectives which focused on helping students actually solve environmental problems and develop problem solving skills is contrary to the recommendations for environmental education objectives contained in both the 1975 Belgrade Charter and in the 1977 Tbilisi Intergovernmental Conference Report.

The answer to some of these concerns might be found in instructional goals for environmental education which incorporate the variables related to "ownership" and "empowerment". Such a set of goals was detailed in Part I of this document. These goals were developed in the early 1980s and subsequently have been used throughout much of the world as a guide for curriculum development and research. This set of goals includes a superordinate goal and four major goal levels which are described below:

**The Superordinate Goal:** . . . to aid citizens in becoming environmentally knowledgeable and, above all, skilled and dedicated citizens who are willing to work, individually and collectively, toward achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment.

#### **Goal Level I. The Ecological Foundations Level**

This level seeks to provide learners with sufficient ecological knowledge to permit him/her to eventually make ecologically sound decisions with respect to environmental issues.

#### **Goal Level II. The Conceptual Awareness Level - Issues and Values**

This level seeks to guide the development of a conceptual awareness of how individual and collective actions may influence the relationship between quality of life and the quality of the environment and, also, how these actions result in environmental issues which must be resolved through investigation, evaluation, values clarification, decision making, and finally, citizenship action.

#### **Goal Level III. The Investigation and Evaluation Level**

This level provides for the development of the knowledge and skills necessary to permit learners to investigate environmental issues and evaluate alternative solutions for solving these issues. Similarly, values are clarified with respect to these issues and alternative solutions.

#### **Goal Level IV. Action Skills Level - Training and Application**

This level seeks to guide the development of those skills necessary for learners to take positive environmental action for the purpose of achieving and/or maintaining a dynamic equilibrium between quality of life and the quality of the environment.

### **Instructional Approaches Associated with the Teaching of Global Change Issues**

As mentioned earlier, the writers advocate that the major content area of global change education should be that of global change issues. The definition of a global change issue is similar to the definition of an environmental issue. What is an environmental issue? An environmental issue is one which has its roots in the environment and which

**"An environmental issue is one which has its roots in the environment and involves a problem surrounding which there are differing beliefs and values."**

involves a problem surrounding which there are differing beliefs and values. A global change issue would be one which involves a global change problem surrounding which there are differing beliefs and values.

Examples of issues fitting this definition would include issues such as : human population growth, land-use management, endangered species, tropical rain forest destruction, clear-cutting in temperate forests, desertification, petroleum-based fertilizer use and food production, loss of non-renewable energy resources, wetlands conversion to agriculture and human habitation, the use of high-sulfur coal for the generation of electricity, air pollution, and nuclear power generation.

Two rules govern the identification of an environmental issue: (1) *it must truly be an issue*, i.e., people must, at some point, disagree concerning the status or resolution of the issue (differing beliefs and values are present), and (2) *it must have social and/or ecological significance and be related, in some dimension, to the environment*. Given that a problem/issue meets these criteria, one can assume that an environmental issue has been identified.

## Outcomes of Issue Instruction

Certainly, a major goal for environmental education is to develop a learner who can become an effective citizen in the world community and be able to contribute to the solution of environmental issues. This goal demands a number of prerequisite skills. These include: (1) the ability to *identify global change issues*, (2) the ability to *analyze issues, and correctly identify the "players"* (individuals or groups involved in issues) and their beliefs and values, (3) the ability to *investigate global change issues* in a manner as to identify the facts surrounding them and their proposed solutions, along with their social, economic, political, legal, and ecological ramifications, (4) the ability to *evaluate these issues* and to determine the most effective means of resolving them, (5) the ability to *develop an "action plan"* which can be implemented in an attempt to resolve or help resolve a particular issue, and (6) the ability to *execute an action plan* if that plan is consistent with his/her personal values.

**Global change issue instruction must incorporate direct training in citizenship skills.**

These are not instructional objectives familiar to most instructors, are they? And yet, these skills are ones which would serve tomorrow's citizens well. Meeting these instructional objectives, however, may not be an easy task and will probably necessitate a great commitment on the part of the professional education community and EE instructors specifically. If we look at the body of research concerning issue instruction, some very important findings become apparent. These include:

1. Although textbook coverage of global change issues is on the increase, there is a lack of issue coverage available for use by the teacher. Where global change issue coverage is present, it tends to be at an awareness level, without opportunity for in-depth student investigation of issues or training for citizenship responsibility.
2. Global change issue instruction is not a pervasive arena for instruction in today's classrooms. Where it is found, it remains, by and large, an awareness activity. Thus, the really critical outcomes associated with issue instruction are not being realized.
3. If citizenship performance is a desired state for students, it will not be attained by teaching global change issues at an awareness level. If we want future citizens to be responsible global citizens we must teach them how to be responsible.

It appears, then, that issue instruction must transcend a simple awareness of global change issues and incorporate direct training in citizenship skills associated with issue remediation. The writers are also of the opinion that, when in-depth investigation skills are taught along with citizenship issues action skills, substantial citizenship behavior will result.

The writers recommend four "Instructional Levels" to be used in global change issue instruction. These instructional levels parallel the goal levels described earlier. However, the goal levels which follow are focused on global change issue instruction

specifically, rather than on environmental issues or on the environmental education curriculum. The four "Instructional Levels" follow:

### **Instructional Levels for Global Change Issue Instruction**

#### **Level I: The Foundations Level**

This instructional level provides learners with the prerequisite scientific knowledge (content) needed to understand and investigate the global change issue(s) in question.

#### **Level II: The Issue Awareness Level**

This level provides learners with the conceptual knowledge associated with discrete issues. It involves an understanding of the "anatomy of issues" including what separates problems and issues as well as the varying beliefs and values held by societal members which impinge so heavily on the origin and resolution of issues. At this level, students also become involved in analyzing the ecological and social/ cultural implications of issues and solutions (e.g., economic, political, legal consequences, etc.). This goal also involves students understanding the need for them to become involved in issue investigation, evaluation, and resolution.

#### **Level III: The Investigation and Evaluation Level: Training and Application**

This level provides learners with the knowledge and skills necessary to permit them to investigate/analyze issues and evaluate alternative solutions for resolving these issues. It also involves some form of student involvement in the investigation process, including data collection, interpretation, and communication.

**Level IV: The Issue Resolution Level: Training and Application** This level provides learners with the skills necessary for making responsible decisions concerning the resolution of global change issues. Likewise, it provides learners with an opportunity to prepare and evaluate "action plans" for issue resolution. Additionally, it supports the application of citizenship action strategies if and when students are motivated to apply their action plans.

### **Two Options for Dealing With Global Change Issues Across Content Areas: The Extended Case Study Model and the Issue Investigation and Action Model**

It appears as though there are two promising and educationally viable options for dealing with global change issues in the secondary school. One of these rests with the development and presentation of case study units. The other focuses on training students to actually investigate issues on their own and on providing opportunities for such investigation. Both of these options can allow for indepth issue coverage. However, there are advantages and disadvantages associated with each of the approaches.

#### **The Case Study Format of Issue Instruction**

The case study is, by and large, a teacher-directed analysis of a particular issue. It is an instructional method which utilizes both primary and secondary sources to deliver issue-focused information and skills to learners. These sources are, at least initially, used by the teacher to aid students in developing a foundation of knowledge concerning the issue. Once students are oriented to the issue, the teacher leads the students in an investigation of the issue on a class or small-group basis. Such a strategy could involve the students in a search of additional secondary sources of information, searching, perhaps, for new data sources that could be synthesized by the class. Or, it could involve a class decision concerning needed information or questions in need of answers at the local/community level.

If the instructor/class decides that primary information is needed, this could lead to the development of survey instruments (questionnaires and/or opinionnaires) and the production of an instrument that the entire class could administer in the community/area. Of course, this would lead to the collection of primary data which would be recorded and interpreted by the class. Once class decisions are made concerning what should be done with respect to the issue, the time has come for considering the potential for issue remediation and the eventual development of an action plan which may or may not be implemented (depending on decisions made by the instructor/class).

The case study provides the teacher with a substantial amount of flexibility and control. The extent to which the issue is dealt with is in the hands of the teacher. The teacher can choose the issue, determine the methods to be used, make decisions concerning the depth to which the issue will be studied/analyzed, select the exact point at which the case study will be infused into the existing curriculum, and determine the length of time to be spent on the case study.

There is, however, a price that must be paid for flexibility and control! The costs involve time, energy, and skill in putting the case study together. Most issue case studies are a "do it yourself" curriculum with the instructor as the curriculum designer. Although students can be involved in the selection of a case study, that responsibility generally rests with the instructor. So, too, does the responsibility for finding and selecting sources such as printed matter, video tapes, guest speakers, panel discussion members, films, field trips, or simulation activities. Handouts must be prepared. Evaluation instruments must be designed. The development of a good case study is certainly not an easy task.

**The writers have developed a detailed "outline" of a four goal level case study. This case study can be found in Appendix A. The particular issue focused on here is "livestock farming" which is far more important in global change matters than most people realize. Using this as an example helps demonstrate the very broad array of issues which are involved in global change.**

**The Issue Investigation and Action Approach  
for Dealing With Global Change Issues in the Classroom**



The case study approach to issue investigation focuses on only one issue category at a time, e.g., tropical rainforest management. The issue itself is the intent of case study instruction. As a result, the instructional activities are issue specific. In contrast, the investigation skill method employs a broader, more generalizable approach to the process of issue investigation. The intent of the investigation methodology is to develop in students the skills involved in issue investigation and resolution so that they can be applied throughout life. Unlike the case study approach, this method provides for the definition, practice, and application of knowledge and skills needed by learners to independently investigate and resolve issues.

Investigation/evaluation skill development builds on the awareness level and proceeds through to the action level. Students learn to differentiate between *problems* and *issues* and, in so doing, gain a very important understanding concerning the nature of environmental (social) issues, i.e., people disagree about their resolution, and those disagreements are based on differing beliefs and values related to issues. That understanding provides the basis for the development of a critical skill, that of issue analysis. This ability to analyze issues involves the identification of the different individuals or groups of individuals (players) involved in an issue, and of the positions taken by those players regarding issue resolution. Also involved in issue analysis are the identification and comparison of the beliefs about the issue held by these players, as well as of the values implied by their belief statements.

The ability to analyze issues also includes the identification of the implications, or consequences of issues and of their proposed solutions. Important consequences would include those which are ecological, as well as those which are social, political, economic, cultural, legal, and so on. Thus, issue analysis provides the learner with a mechanism for understanding complex social and environmental issues. As such it is a potent organizational tool for the learner.

As was stated above, a major purpose of this approach is to develop an autonomous (independent) investigator. In order to accomplish that end, important skills which must be developed involve formulating problem questions, identifying sources of information to answer those questions, and designing strategies to attain that information. Simply put, the learner must become skilled in answering questions such as: what do we need to know about the issue; where can we get that information; and how can we get it?

**A major purpose is to develop an independent [issue] investigator!**

In order to gain those skills, learners are given the experiences of researchers. Subsequent to learning how to generate research questions, they are taught to effectively use both primary and secondary sources of information in the investigation of issues. Locating and accessing information from appropriate agencies, resource people, and library sources are important aspects of information gathering. Additionally, learners become adept at analyzing information (and information sources) for bias. The ability to compare and contrast discrete pieces of information, and to identify the values and beliefs inherent in each are important and powerful analytical tools, and learners must be given opportunities to practice those skills on a variety of issue-related information.

Students also learn that primary information might be gathered through the use of interviews, or through instruments such as surveys, questionnaires, and opinionnaires. In training learners in the design and administration of survey instruments, an application component is essential. Thus, we cannot simply tell students *how to* design and administer

instruments. . . we must also allow them to *become involved in* the design and administration of instruments. And, following the collection of data pertinent to the research question(s), the interpretation of those data must be attended to. Therefore, learners receive instruction and practice on generating logical conclusions and inferences, and on making appropriate recommendations based on the data collected, rather than on emotion.

**Learners develop the abilities to gather and evaluate information about global change issues!**

Since a major purpose of this approach is to develop autonomous investigators, the writers encourage instructors to permit students to engage in an independent investigation into an issue of their own choosing. Such a thorough investigation is prerequisite to sound decision making in the environmental realm, and to responsible participation in citizenship action related to the remediation of global change issues. It appears that this component is necessary in order to provide an opportunity for students to apply the skills which they have been taught, thereby reinforcing those skills.

An autonomous investigation also allows a students to make an "investment" of his/her talents, interests and time in a preferred issue. Not only do students become experts regarding that issue, but they also derive a sense of "ownership" toward that issue. This sense of ownership, or feeling of responsibility provides the impetus for action-taking in a positive manner.

Citizen action training, the final component of this skill development approach, seeks to develop individuals who are capable of making wise choices regarding appropriate and effective citizen behaviors and who are willing and able to apply those behaviors responsibly to environmental issue remediation. Thus, learners become familiarized with the methods of action at their disposal as citizens, and become skilled in the use of those actions. In the United States, those actions include ecomanagement, persuasion, consumerism, political action, and legal action. Moreover, decision making skills are sharpened as learners evaluate proposed actions with respect to their effectiveness and appropriateness, and with respect to the ecological, social, economic, political, and other cultural consequences of the proposed actions. Finally, learners are asked to formulate a plan of action which they might utilize in relation to the environmental issue which they have investigated. The instructor is also urged to provide learners with the encouragement and support to implement their action plans.

**Learners develop the abilities to make sound decisions regarding appropriate environmental maintenance and remediation, and to take action as responsible citizens in helping to resolve issues.**

Thus, in the skill development model, learners develop the abilities to gather and evaluate information about global change issues, to make sound decisions regarding appropriate environmental maintenance and remediation, and to take action as responsible citizens in helping to resolve issues.

This approach, as with most instructional methods, has a variety of problems and limitations. Because it is a developmental approach, it requires careful sequencing and sufficient time, and may not easily lend itself

to infusion into an existing curriculum. Educators have typically found that an entire eighteen week semester is needed to complete the learner objectives. The model is quite appropriate, however, to a team approach, where a science teacher, social studies teacher, and/or

language arts teacher join forces, sharing the particular subject matter expertise of each. Interestingly, this team approach can shorten the time needed for this model.

Further, classroom management techniques are critical in those aspects of instruction where the students are actually investigating a large number of different issues. Here the instructor must act as a facilitator between a variety of resources and the many students in the process of investigating issues. In particular, some instructors have found it difficult to make the transition from direct instruction to a role which demands advising and consulting. Allowing students to independently investigate environmental issues is sometimes viewed by teachers as an unfamiliar and threatening departure from "traditional" classroom management practices.

**An extensive description of the sequence of skills which are developed and utilized in the issue investigation and action training approach can be found in Appendix B.**

### **Comparing the Two Approaches**

Both the case study and the investigation skill approach provide instructional strategies by which teachers can effectively deal with issue investigation. Both strategies share similar instructional goals and activities but differ significantly in scope, teacher and student postures, instructional time demands, and a variety of other curricular and classroom management factors. The following chart compares the issue case study and investigation skill approaches across a number of educational variables.

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**Comparison Chart: The Case Study Format vs  
The Issue Investigation Skill Development Approach**

<b>Educational Variable</b>	<b>Case Study</b>	<b>Skill Development</b>
<b>Characteristics of Students:</b>		
1. Grade Levels	Recommended Gds. 4-12	Appropriate for Gds. 6-12
2. Student Role	A receiver of information independent and large group researcher	An autonomous, researcher; skilled in citizenship action skills
3. Ability Levels	Wide range of abilities	Wide range of abilities
4. Sense of "Issue Ownership"	Not necessarily the case	Typically, students have a strong sense of ownership
<b>Characteristics of Instruction</b>		
1. Issue Focus	Single issue treatment; issues most often chosen by teacher	Multiple issue treatment; issues chosen by students
2. Instructor's Posture	Initially, very traditional, subsequently as a facilitator/consultant during class investigation	Traditional posture followed by role as a consultant and facilitator as students investigate numerous issues
3. Time Demands	Variable - depends upon the case study and the activities involved (2-6 weeks)	Typically, eighteen weeks, with one hour per day of instruction in secondary school
4. Risk of Experiencing a Syntax Problem	High risk	Low risk
5. Need for Inservice Training	High need	Very high need
6. Potential for Infusion into Existing Programmes/ Courses	Very high potential	Moderate potential - requires separate time block
7. Team Teaching Potential	Moderate potential	Very high potential
<b>Educational Variable</b>	<b>Case Study</b>	<b>Skill Development</b>

**Outcomes of Instruction:**

1. Knowledge of a Broad Range of Global Change Issues	Low	High
2. Process (Skill) Acquisition	Low-moderate	Very high
3. Citizenship Action Skill Acquisition	Typically, issue specific	A generic set of skills is acquired - high transfer potential
4. Citizenship Responsibility (Out-of-School Behavior)	Moderate behavior observed if instructor covers the skills	A great deal of behavior observed out-of-school

**Materials:**

1. Source of Materials	Teacher constructed except for issue literature/films, etc.	Published materials are available
2. Expense	Relatively low, depends largely on the issue	Moderate if published materials are put into the hands of the students

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**Other Strategies Appropriate for Global Change Instruction**

Regardless of the teaching model used for instructional purposes in global change instruction, certain teaching methods and instructional resources will prove necessary in order for instruction to be maximally effective. Students cannot be expected to change their behavior and become effective and responsible citizens when only lecture and discussion are used in the teaching-learning process. For example, learners cannot be expected to investigate global change issues unless they have the skills needed for, and experience in, the process of issue investigation. Similarly, one would not expect students to be skilled and responsible decision-makers, unless they had become acquainted with decision-making processes and had been provided with opportunities to apply those skills

A number of instructional strategies are recommended for use when undertaking global change instruction with secondary students. A brief overview of some of these strategies and of the resources associated with their use is presented on the following pages. The instructional levels utilized in this chart parallel the global change instructional levels presented on page 68 of this document. Following this strategies/resources chart, a few of the methods are discussed further.

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**Using a Goal-oriented Framework as a Basis for  
Organizing Instructional Strategies and Resources\***

<b>Goal Level Resources</b>	<b>Available Methods</b>	<b>Available Resources</b>
Ecological Foundations	Field Studies/Local Local	Natural Areas, Refuges, Environmental Centers, Nature Centers, Etc.
	Simulations and Models	Computer Programmes, Diagrams, Printed Simulations.
	Viewing and Discussion	Video Tapes, Movies, Filmstrips.
	Reading and Discussion	Texts and Other Print Materials.
	Lecture and Discussion	Overheads, Worksheets, Lecture Notes, Followup Panel Discussions.
Conceptual Awareness	Field Trips	Local, Environmentally Impacted Sites, Sites of Issue Foci.
	Simulations and Models	Computer Programmes, Diagrams, Printed Simulations.
	Case Histories	Teacher Developed Case Histories, Print Materials, Community Resource People.
	Brainstorming (Problems, Issues & Solutions)	Teacher Organized Brain- storming Sessions.
	Viewing and Discussion	Video Tapes, Movies, Filmstrips.
	Reading and Discussion	Textual and Other Print Matter.
	Lecture and Discussion	Overheads, Worksheets, Lecture Notes, Followup Panel Discussion.

\*Adapted from a similar table by Tom Marcinkowski in Hungerford et al (1988).

**Using a Goal-oriented Framework as a Basis for  
Organizing Instructional Strategies and Resources**

<b>Goal Level Resources</b>	<b>Available Methods</b>	<b>Available Resources</b>
	Issue Analysis (Players, Positions, Beliefs, and Values)	Worksheets Involving the Issue Analysis Procedures; Films & Print Materials as Referents.
	Brainstorming of Alternate Solutions	Teacher Organized Brainstorming Sessions, Focus on Student Involvement.
Investigation and Evaluation of Issues	Secondary Source Investigations	Libraries and Other Collections.
	Primary Data Collection	Data Collection Instruments, Samples as Needed.
	Value Clarification/ Moral Education	Print Materials, Valuing Exercises.
	Role-playing and Simulations	Print Materials, Required Resources made Available.
	Panel Discussions and Debate	Print Materials, Required Resources made Available.
Environmental Action Skills	Skills Training Sessions	Print Materials and Exercises.
	Action Workshops	Community Resource Persons.
	Action Analysis	Worksheets Using the "Action Analysis Criteria".
	Student(s) Action Projects	Teacher and Resource Persons as Supervisors/ Consultants; Required Resources Made Available.
	Action Learning in Community Internships	Community Programmes and Projects, Cooperating Organizations.

### **Inventorying and Using Community Resources**

We are almost certain that students coming from a classroom where community and regional resources are not used instructionally will have only limited ecological knowledge,

will not be aware of the resources of their region, will not be able to investigate serious issues within the region, and will not know how to help resolve the important global change issues facing them and the community. This unfortunate state-of-affairs could be remediated, at least in part, by teachers using community/regional resources in their teaching.

A teacher (or teachers) can become acquainted with local resources through the development of a "resource inventory". A resource inventory is simply an inventory of the physical and human resources available for global change instruction within the teacher's own area. This inventory can take the form of a book or a manual, it can be computerized, or it can be developed as a card file to be used by all faculty members in a school.

**. . . students coming from a classroom where community and regional resources are not used [educationally] will not know how to help resolve . . . global change issues . . . .**

What kinds of resources can be inventoried for an environmentally related resource inventory? A few examples would include resource people such as chemists, biologists, forestry scientists, environmental scientists, soil scientists, animal husbandry specialists, utility company personnel, sewage plant operators, greenhouse operators, environmental organization activists, and

ranchers/farmers. Other examples would include physical resources such as national/state forests, farms, ranches, local ecosystems (biomes), cattle finishing yards, sewage plants, family planning clinics, waterworks, electrical utilities, commercial airports, strip mines, fertilizer industries, toxic waste dumps, and university facilities of various sorts.

### **Effective Use of Field Trips**

In order to be effective, the field trip should always be task oriented. A simple excursion outside of the formal classroom is usually a waste of time. Therefore, it is up to the instructor to provide the parameters needed to insure success. The "task" for the student can be one of several types. It can involve answering one important question in depth. It can involve some sort of inquiry which demands that problem solving skills be applied. It can involve a survey which necessitates the use of a data collection instrument. It can simply involve a student-generated description of something which is not available within the confines of the regular classroom (e.g., a passive solar greenhouse, a beef cattle ranch/farm, etc.).

Besides providing a definite task for the students on a field trip, several other considerations are important. Among these are:

1. Arrangements for transportation when needed.
2. Plans for student safety.
3. A preliminary trip to make sure that the instructor is familiar with the resource.
4. Pretrip discussions with students about the nature of the trip, the resource and their assigned tasks.
5. Discussion concerning student deportment on the trip, i.e., expectations of student behavior.
6. Posttrip data recording and synthesis. Reports by individual students or small groups may be indicated.



**. . . the field trip  
should always be task  
oriented!**

Other parameters may be needed, depending on the nature of the trip. If the instructor is taking the class on a trip to a cattle farming operation, for example, students may be assigned an additional task of observing other agricultural and land use management practices along the route to the farm. Or, if the trip is to an excellent example of the dominant ecosystem (biome) the instructor may ask students to take notes on the way home on the ways in which man has modified the biome.

A sample worksheet, designed for use during a field trip to an electric generating plant has been included in this section and can be found on the facing page. Similar worksheets can be designed for use during visits to any resource related to global change topics.

### **Using Role Playing and Simulations**

Simulations provide opportunities for individuals to explore the various players, positions, beliefs and values present in global change issues. Role playing permits the learner to "get inside" the issue as he/she assumes the role of a particular player and interacts with other players in attempting to resolve the issue. Although it requires some skill on the part of the instructor, this model has great potential for demonstrating the relevance of textbook information to real-life experiences. It also provides the students with practice in making important decisions and in developing action-oriented human relations skills. This type of socio-drama is probably an ideal activity for maturing adolescents, as it permits them to "try out" alternate beliefs and values and thus to test and validate their own beliefs and values.

Role playing can be conducted using either small or large groups. In the small group procedure, most of the class members will act as observers. Their participation occurs after the role players have made a decision, if time is set aside for discussion and comments. Often non-participating students are eager to comment on the decisions made by others, even if they lack the confidence to fully engage in role-playing. For these individuals, this procedure provides them with good modeling for future role-playing in which they might wish to participate.

Large group simulations, of course, have the advantage of full involvement by all class members. Simulations set in general meetings, such as town meetings, commissions, public hearings, etc., necessitate the roles of principal players, and of supporting players. An example of this large group simulation can be found in Wilke, Peyton, & Hungerford (1980). This simulation entitled "The President's Commission on Population", describes a meeting of a presidential advisory commission on population policy, and includes the roles of principal players who will testify before the commission (e.g., economist, agriculturalist, Planned Parenthood representative, environmentalist, etc.). Also included within the simulation might be the roles of commission members themselves, who must make a decision related to the recommendation of a population policy.

Generally, this type of simulation includes the assignment (or selection of roles) and requires research and preparation on the part of class members. Students should understand in advance that role playing is no joke, that there will always be a specific agenda, and that a timetable will be strictly adhered to. This should help them to keep on task. They should be assured in advance that once the role-playing session is underway, no breaking of roles will be tolerated.

## **A Sample Field Trip Work Sheet**

### **The Electric Utility Generating Plant**

1. Briefly describe the geographic location of the generating plant.
2. What geographic area is served by this plant's electricity output?
3. A. Is any of the electricity produced here sold to other utility companies? If so, what percentage?
3. B. Is any electricity being purchased by this utility company? If so, what is the source? Is any of this electricity produced by renewable resources, e.g., wind or solar?
4. What is the fuel used in this plant? Coal? \_\_\_\_\_; Oil? \_\_\_\_\_; Gas? \_\_\_\_\_; Nuclear? \_\_\_\_\_; Other? \_\_\_\_\_ (Describe).
5. If coal is used as the fuel, is it high or low sulfur coal?
6. If coal is used as the fuel, where was it mined? How was it transported?
7. If high sulfur coal is used, what strategies are employed to cut down on stack emissions?
8. Can you observe any emissions coming from the plant? If so, what type of emissions (vapor, smoke, water output etc.)?
9. If the fuel is nuclear, what is its source? How was it transported?
10. How are nuclear wastes disposed of by this firm? Are nuclear waste disposal regulations being met? Who writes the regulations?
11. What are the qualifications of the personnel responsible for running this electric generating plant? What kind of education is demanded of them? How much experience do they have?
12. Is the demand for electricity expected to increase over the next ten years? If so, by how much?
13. After visiting and observing the plant, what environmental interactions can you observe between this utility plant, people served by it, and the environment - both local and beyond?
14. Many environmental scientists are adamant that the only way to truly resolve the energy problems is through conservation (i.e. using less energy, using energy more efficiently). What are your thoughts about this after visiting this plant? What could residents and commercial consumers do to conserve electricity and thereby reduce the demand placed on the plant you saw?

When describing the simulation, the instructor should be very clear about the decision(s) to be made. The nature of the decisions will cue students about the information they should gather and prepare. Students should be advised to consider what alternate decisions can be made, to discuss the alternatives in terms of information, the value perspectives of their roles, and their personal values, and then, to make a decision. The instructor should avoid provide a full outline of each player's position, if possible. Otherwise, the student might discuss what they feel the instructor thinks is important, rather than focus on their own research and thinking.

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## Sample Role Playing and Simulation Activity

### A POPULATION COMMISSION

**Prerequisites:** Prior to the simulation, students should be familiar with basic concepts associated with populations dynamics; select population issues; and general familiarity with population problems as one global change issue.

**Purpose:** For secondary school students, the desired outcomes of the simulation activity will be a determination of: (a) the nature and extent of population growth in their country (i.e., past, present, projected); (b) the identification of factors which influence both the increase and decrease of this growth; (c) the variety of interests, positions, and issues associated with population growth and with efforts to modify it; and (d) the most acceptable means of influencing the rate of growth, if this is deemed necessary.

**Scenario:** A "National Commission on Population and the Future" has recently been convened by your government. The charge of this Commission is to develop the guidelines for a governmental policy on population growth for your country. Only three directives were given to this Commission: (a) it must hold a series of regional hearings as a means of soliciting information and expert testimony relevant to this charge; (b) the final hearing must involve one representative from each major interest group which participates in regional meetings; and (c) following this final hearing, Commission members must hold a working session with these representatives in an effort to arrive at a mutually agreeable set of guidelines to recommend to governmental leaders. This simulation covers the final hearing and the working session.

**Representatives:** It is recommended that the number of representatives be determined on the basis of the population-related conditions existing in each country. However, it is important to recognize that this simulation is best suited for a minimum of six (6) representatives. It is also recommended that the following sectors of a society be adequately represented:

- a. Governmental Agencies such as those which oversee immigration and emigration, agriculture, health care, and employment (e.g., in the U.S.: Immigration and Naturalized Services, and the Departments of Agriculture, Health and Human Services, and Labor);

- b. Fields of Academic Analysis such as those involving the study of population and demographics, agriculture, health care, and economics;
- c. Social Institutions with an interest in population affairs such as religious and labor organizations (e.g., in the U.S.: Catholic, Protestant, and Jewish Institutions, and interested Labor Unions);
- d. Socio-economic groups such as the middle and lower classes (e.g., a representative for the uneducated, homeless, poor, and/or starving);
- e. Advocacy groups such as the World Population Institute, Zero Population Growth and Planned Parenthood, pro-life and pro-choice groups, and urban-based and environmental groups; and
- f. Advocates of other recognized positions.

Examples of representatives and the positions they might take include:

- a. **AN AGRICULTURAL EXPERT:** As an agriculturalist, you are aware of the implications of a growing population, and its demands on food production as first voiced by Thomas Malthus. You have been involved in past efforts to help increase food production (e.g., the Green Revolution), and are carefully monitoring new agricultural advances (e.g., in the area of bio-technology). At the same time you are concerned about the effects of national supply and international demand on both product costs and inflation. Your task is to generate a position statement which develops these considerations into a logical argument for population stabilization.
- b. **A REPRESENTATIVE OF THE CATHOLIC HIERARCHY:** You represent the views of the Catholic Church. Although you recognize overpopulation as a serious problem (e.g., in places where many die of starvation and disease), you uphold the teachings of the Church regarding birth control, sterilization, and abortion. You may invoke the papal encyclical "Humanae Vitae" in defense of your position. In developing your statement, it might also be helpful to interview several Church officials.
- c. **ZERO POPULATION GROWTH:** As a representative of ZPG, you advocate world population stabilization. Your concerns cover a wide range of issues, including population growth, family size, immigration, teenage pregnancy, abortion, and national growth policy. Your task is to develop a position which adequately reflects ZPG's policies, with particular attention to each of these sub-issues.
- d. **PRO-TECHNOLOGY/ECONOMIC DEVELOPMENT:** On the one hand, you are a firm believer in the potential of technology. In your view, population per se is not the problem. Rather, the problem lies in the location of growth centers and the management of technologies to serve them (e.g., in areas like shelter, transportation, and food production/distribution/energy). On the other hand, you are keenly aware that when economic growth benefits a majority of the population, it will most probably lead to a reduction in the rate of population growth (e.g., as in Western nations). Your task is to locate noted authorities which support

these or similar positions, synthesize their concerns, and present them to the Commission.

**Structure of the Activity:** This simulation can be organized as follows:

1. **Setting the Stage.** The teacher should establish and communicate to students both the format of and time frame for the simulation. This includes:
  - a. defining the composition of the Commission;
  - b. identifying the representatives to be role-played, and describing the general contribution and/or position of each.
  
2. **Student Preparation.** The teacher should establish and communicate to students what will be expected of them prior to the simulation. This includes:
  - a. having individual students take on the role of an identified representative;
  - b. indicating that they will be expected to conduct background research on the person or group they will represent;
  - c. indicating that they will be expected to develop a position statement based upon their research which reflects accurate, up-to-date information; and
  - d. describing that they will be expected to present expert testimony regarding their position to the Commission during the final hearing and during the working session.
  
3. **The Simulation.** In order to present testimony and arguments in an equitable fashion, and to maintain an atmosphere of mutual respect and acceptance, certain rules must be strictly adhered to.

For the Final Hearing these include:

- a. The Commission Chairperson will determine the order in which the representatives will present their testimony, and will communicate this order to all representatives prior to the hearing; and
- b. Each representative will be given 5 minutes in which to present his/her position, along with supporting information, explanations, and/or arguments. Following the testimony, the floor will be opened to members of the Commission and/or other representatives for questions and discussion. Discussion may be curtailed at the discretion of the Commission Chairperson.

For the Working Session these include:

- c. During the working session representatives and Commission members may enter the discussion only upon recognition by the Commission Chairperson; and
- d. During the working session, comments and discussion on any particular issue will be limited to approximately ten (10) minutes, and may be curtailed at the discretion of the Commission Chairperson.

Synthesis or Summary: After the simulation, the teacher should engage students and other participants in a discussion of the simulation. While allowing for discussion related to role-playing, the teacher should guide discussion toward topics which reflect each of the previously stated Purposes.

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### Panel Discussions

Panel discussions on issues are excellent mechanisms for permitting students to present conflicting viewpoints and to evaluate the merit of different belief and value systems. In examining and evaluating the various ideologies, secondary school students are afforded an excellent opportunity to compare their personal ideologies to those of others.

**Panel discussions . . . are excellent mechanisms for permitting students to . . . evaluate the merit of different belief and value systems.**

A panel discussion can directly involve from two to ten students in active discussion and can indirectly involve the entire class. In general, it would be a good idea to plan a series of panel discussions on a variety of global change issues and the, subsequently, on a synthesis of these issues and how they relate overall to global change. It will be necessary for the instructor to prepare well for this. Major global change issues should be identified and an issue statement generalized for each one. A collection of articles and written information on each of the issues must be gathered together, and care should be taken that the major players/positions involved in each issue is well represented in the written material.

After the students select or are assigned to issue topics, they should become acquainted with all the material related to their topic which has been gathered by the instructor. They should also be encouraged to seek additional information which might be useful in discussing their issue. A week before the scheduled panel discussion, the students assigned to each issue are divided into two or more groups (enough groups to represent the major players involved in that issue). Although students do not know their "position" well in advance, they can still prepare for the discussion by surveying all available material, thereby becoming versed in their "opponent's" viewpoint as well as their own. Once positions are assigned, of course, the students representing that position must work together on their presentation of that position.

In each panel discussion, opportunities must be made so that positions can be presented, the positions can be clarified as needed, supporting arguments can be mounted, and questions and comments encouraged from the audience. A free dialogue is very important. As much time as seems appropriate should be allowed for each panel's presentation. If necessary, the instructor can help synthesize important information at the close.

## Part IV

### Guidelines for Incorporating Global Change Instruction into Existing Curricula

*There is a need to promote general and environmental education as a condition for sustainable development, and for generating and disseminating [global change] information, in order to improve understanding of impacts and possible responses.*

*Assessing Winners and Losers in the Context of Global Warming, UNEP Workshop, 1990.*

It appears that responsible citizen behavior is a driving force for environmental education, and for education focusing on global change. Thus, changing learner behavior with regard to responsible environmental action becomes a major goal of those educational endeavors. Research suggests that we can maximize opportunities to change learner behavior in the environmental dimension if educational planners would . . .

1. . . . provide a curriculum that will teach environmentally significant ecological concepts and the environmental interrelationships that exist within and between these concepts.
2. . . . provide a curriculum in which there can be carefully designed and indepth opportunities for learners to achieve some level of environmental sensitivity which will promote a desire to behave in appropriate ways.
3. . . . provide a curriculum that will result in an indepth knowledge of issues.
4. . . . provide a curriculum that will teach learners the skills of issue analysis and investigation as well as provide the time needed for the application of these skills.
5. . . . provide a curriculum that will teach learners the citizenship skills needed for issue remediation as well as the time needed for the application of these skills.
6. . . . provide a curriculum that will allow for instructional settings which will increase learners' expectancy of reinforcement for acting in responsible ways, i.e., attempt to develop an internal locus of control in learners. (Hungerford & Volk, 1990)

The above describe broad guidelines in curriculum planning for global change instruction. As such, they suggest an overview for global change instruction. Inevitably,

however, additional concerns arise related to the way(s) in which global change instruction might be incorporated into the secondary school setting.

Global change instruction can be incorporated into the secondary school as a supplement in existing courses, as an infused unit or module, or as a single subject in the overall curriculum. Supplementary lessons or activities will probably do very little to change learner behavior in either the short run or the long run. Therefore, it is not recommended. The single subject approach is by far the easiest to incorporate into a curriculum as it demands the attention of fewer trained professionals. However, in many if not most secondary schools it would be difficult to find room in an already crowded curriculum for another course on global change (irrespective of how important the topic is). Thus, one is repeatedly drawn to an infusion model for incorporating global change instruction into the secondary school curriculum.

### **The "Infusion Institute"**

If time and other resources permit, an "Infusion Institute" can be designed which would permit faculty members to be trained in infusion techniques and provide time for them to plan for the infusion of global change content and skills. In addition, such an institute would allow participants to identify barriers to infusion and develop strategies for removing these barriers. This strategy will often counteract a common behavior which consists of looking for problems more diligently than looking for solutions. Human nature being what it is, excuses are far easier to come by than solutions to problems.

Infusion is a relatively simple process to understand but a rather complex process to accomplish. Simply stated, infusion refers to the integration of content and skills into existing courses in a manner as to focus on that content (and/or skills) without jeopardizing the integrity of the courses themselves. In the case of global change education, the educator carefully analyzes existing courses for places where environmental content and associated skills could be incorporated. Appropriate courses for infusing global change instruction might include agriculture, home economics, health, science, social studies (e.g., geography, political science, economics, etc.), and language arts.

A key component in the infusion process is the faculty of the school responsible for incorporating an infused global change education programme. A comprehensive infusion strategy demands a great deal of cooperation from staff members who are going to be responsible for the infused programme. Faculty members must be sympathetic toward the infusion able to work cooperatively to build a plan for infusion, and willing to see that the plan is carried out. A major ingredient of the "plan" must be to respect the integrity of the scope and sequence of global change instruction in a manner that guarantees that this instruction will proceed logically across content areas. Sometimes this can be accomplished by teachers working independently of others, but often it necessitates team teaching with instructors from two or more content areas working cooperatively.

**Infusion refers to the integration of content and skills into existing courses, without jeopardizing the integrity of the courses.**

### **Planning for Infusion in the Secondary School**

There are basically two ways in which EE can be integrated into existing secondary school programmes: (a) through the creation of interdisciplinary course offerings which emphasize ecology, environmental issues and/or the resolution of those



issues; and (b) through the creation of multi-disciplinary course offerings whereby the contents and skills of EE are infused into existing disciplinary courses.

A simple matrix, such as the one presented on the following page, can be useful in helping professional educators conceptualize basic infusion strategies. This matrix helps to identify at least five different kinds of basic infusion strategies. While these serve as "building blocks" for infusion planning, they should not be seen as the only infusion strategies available.

### The Discipline Area Course

		<u>Contents</u>	<u>Skills</u>
<u>Contents</u>		A. Matches between disciplinary contents and EE contents (e.g., inclusion of ecological concepts in a biology course)	C. Using EE contents with disciplinary skills (e.g., using ecological examples when teaching scientific data interpretation, or using environmental articles when teaching students to identify bias in written communications)
<b>The Field</b>		B. Using EE contents as examples or applications of disciplinary contents (e.g., using environmental examples to illustrate the legislative process or social movements)	
	<u>Skills</u>	D. Using disciplinary contents with EE skills (e.g., conduct an issue analysis of a global change issue of national importance)	E. Matches between disciplinary skills and EE skills (e.g., teaching basic process skills in science, or social/citizenship participation skills in the social studies)

Each of these basic infusion strategies requires that educators conduct a careful and thorough identification of the global change contents (concepts) and skills emphasized in particular units of a secondary school science or social studies course. Once the content and skills lists have been prepared, instructors should be ready to review the lists for infusion opportunities. (Material in the above section is adapted from Marcinkowski et al., 1990.)

Should one be interested in possibilities for infusing important issue investigation skills into existing traditional curricula or into basic inquiry (problem solving/research), the table on the following page lists issue investigation skills and identifies four disciplinary areas in which individual skills might be infused. This selection of language arts (LA), science, social studies, and basic inquiry for this type of analysis is not intended to exclude infusion of these skills into other subjects or courses, as appropriate.

**Issue Investigation Skills: An Inventory for Possible Infusion into  
Science, Social Studies, Inquiry, and Language Arts Courses**

<b>The Skill</b>	<b>Science Studies</b>	<b>Social</b>	<b>Inquiry</b>	<b>L.A.</b>
Sampling	X	X	X	
Comparing Info. Sources		X		X
Problem Identification	X		X	
Issue Analysis	X	X		
Classification	X	X		
Synthesis		X	X	
Evaluation	X	X		X
Communication (Written)	X	X	X	X
Communication (Oral)	X	X	X	X
Comparison	X	X		
Summarizing Information		X		X
Values Clarification		X		
Writing Research Questions	X	X	X	X
Writing Survey Instruments	X	X	X	
Data Collection	X	X	X	
Data Recording	X	X	X	
Graphing	X	X	X	
Data Interpretation	X	X	X	
Citizenship Action Skills				
Consumerism		X		
Political Action		X		
Persuasion		X		X
Ecomanagement	X	X		
Action Analysis/Evaluation	X	X		

## Some Insights Into Infusion

Over the past several years, the authors of this document have spent a good part of their professional lives training teachers in environmental content and issue investigation strategies. One of the things to come out of this training is the knowledge that environmental content and skills can often be integrated into existing courses without interfering with the content and skills desired by involved faculty members.

Let us look at a few examples of where environmental content has been successfully infused in U.S. schools. For example, in a New Jersey (USA) school there was an interest in implementing environmental issue instruction using a team-teaching approach (infusing issue instruction into science, language arts, and social studies). The language arts teacher was skeptical - unsure whether this infusion would interfere with his program of skill development in the language arts. Even so, he agreed to study the components of issue investigation and respond to the challenge a day later. He came back to the group the next day and stated that the skills involved in issue instruction would meet over fifty percent (50%) of his course objectives. The social studies teacher, concerned that her students had an opportunity to study social problems, had no problem seeing the relationships that existed between environmental issues and social issues since all environmental issues have a strong social dimension. Of course, the science content was obvious.

In another instance, where issue instruction was implemented, the school librarian worked with the science teacher, assisting her with instruction in certain language skills and providing environmentally-related secondary resources for the students. The librarian reported that she was astounded to find that the issue-focused students' research skills were much better than the skills of other students. She was also impressed with the seriousness with which those students approached their library research. The students became so skilled in using secondary sources from the library that they didn't need to be re-taught library skills in subsequent years. One would not necessarily expect this kind of an outcome from an environmental program but this is exactly what happened.

The writers can cite numerous examples of two teachers working cooperatively - typically science teachers working with social studies teachers or language arts teachers to meet the needs of learners. In all instances, some form of infusion was involved. Usually, the science teacher prompted the team-teaching and the infusion but not always. Sometimes, the social studies teacher led the way. It matters not! Infusion took place and cooperative teaching occurred.

In other instances, teachers of home economics and agriculture have requested training for infusing environmental content into their subject matter areas. Many issues

related to global change are suitable for instruction in home economics, e.g., those having to do with energy consumption and conservation, those having to do with the relationships between human reproduction and family living, issues related to environmentally-sound and globally-responsible consumer behavior, etc. In agriculture, numerous global change issues are available for infusion, e.g., issues associated with deforestation and food production, soil erosion, desertification, livestock grazing, loss of agland due to construction, etc. Courses such as

**. . . teachers of home economics and agriculture have requested training for infusing environmental content into their subject matter areas.**

home economics and agriculture can play an important part in an overall infusion of global change education into the secondary school curriculum.

### Pros and Cons of Infusion

The reader realizes, of course, that global change could be dealt with as a separate subject. There are substantial advantages for dealing with it in this manner. Among them would be respecting the integrity of both the scope and sequence of the content and skills.

**Language arts, social studies, science, home economics, health, agriculture . . . are ideal vehicles for infusing global change content and skills.**

Fewer teachers would have to be trained in the content, skills, and methodology associated with the programme. The need for grappling with the problems associated with infusion would be lessened. However, there are also some disadvantages. One marked disadvantage lies in not

being able to use other content areas as vehicles for promoting the knowledge and skills in this scope and sequence. Language arts, social studies, science, home economics, health, agriculture and other courses are ideal vehicles for infusing global change content and skills without threatening the integrity of those courses. Also, one must remember the very important educational concept of reinforcement. If global change is taught effectively across content areas in the secondary school, the opportunity to observe changes in learner behavior outside of school would be increased dramatically.

### Inspecting the Scope and Sequence for Infusion Possibilities

In an effort to provide some assistance to schools desiring to infuse global change content and skills across the curriculum, the writers have constructed a series of tables which provide insight into the potential for infusion. It should be made clear, however, that these tables show possibilities only! Educational needs and opportunities will vary from school to school and a given faculty may choose to infuse quite differently from what is shown in these tables.

### Possibilities for Infusing Global Change Instruction Across Content Areas

Instructional Topics	SC	HE	SS	MA	LA	HO	AG
Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture							

#### FOUNDATIONS LEVEL

Global Change: Information/Issues	X	X	X			X	X
Global Warming							
Impacts of Global Warming	X	X	X	X		X	X
Societal Causes		X	X			X	X
Reducing Global Warming	X		X				X
Barriers to the Solutions	X		X				X

Instructional Topics	SC	HE	SS	MA	LA	HO	AG
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Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts;  
HO = Home Economics; AG = Agriculture

Tropical Deforestation							
What are Tropical Rainforests	X						
History of Tropical Deforestation			X				X
Reasons for Deforestation			X				X
Impact on the Biosphere	X	X					X
The Impact on Society		X	X			X	X
Societal Causes			X				X
Solutions to Deforestation	X		X				X
Barriers to Solutions	X		X			X	X
Human Population as a Global Change Issue							
History of Population Growth			X				
Impact on Society and the Biosphere	X	X	X	X	X	X	X
Solutions to Overpopulation	X	X	X			X	
Barriers to Stabilization	X	X	X			X	
Global Energy Consumption							
Major Sources of Energy	X		X			X	X
Impact on the Biosphere	X						
Impact on Society			X			X	X
Solutions to Resource Consumption	X		X			X	X
Barriers to Solutions	X		X			X	X
Global Land Use							
Causes of Land Degradation	X		X				X
Impact on the Biosphere	X						X
Impact on Society			X				
Solutions to Land Degradation	X		X				X
Barriers to Solutions			X				X

#### **AWARENESS LEVEL**

Human-environment interactions	X		X				
Quality of life vs quality of the environment	X	X	X			X	X
Global change problems and issues	X	X	X			X	X
Analysis of global change issues	X	X	X			X	X
Examples of analyzed issues	X	X	X			X	X
Applying issue analysis skills	X	X	X			X	X

Instructional Topics	SC	HE	SS	MA	LA	HO	AG
----------------------	----	----	----	----	----	----	----

Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts;  
HO = Home Economics; AG = Agriculture

<b>INVESTIGATION AND EVALUATION LEVEL</b>
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Identifying Issues and Preparing Research Questions							
Identifying global change issues	X	X	X			X	X
Identifying variables associated with global change issues	X		X				
Writing research questions	X		X		X		
Using Secondary Sources							
Secondary sources of issue-related information					X		
Processing information from secondary sources			X		X		
Reporting secondary source information						X	
Using Primary Sources							
Surveys, questionnaires, and opinionnaires	X		X		X		
The interview					X		
Selecting the population	X		X	X			
Procedures of sampling	X		X	X			
Data collection strategies	X		X				
Developing and using instruments/interviews	X	X	X		X	X	X
Interpreting Data from Global Change Issue Investigations							
Organizing data in data tables	X		X	X			
Communicating data by graphing	X		X	X			
Interpreting data	X		X		X		
Applying data interpreting skills to issue-related data sets	X	X	X			X	X
The Independent Investigation of a Student-Selected Global Change Issue							
Selecting an issue . . .	X	X	X		X	X	X
Writing research questions	X	X	X		X	X	X
Collecting secondary information			X		X		
Collecting primary information	X	X	X	X	X	X	X
Issue analysis/data interpretation	X		X	X	X		
Communication of results					X		

<b>ISSUE RESOLUTION LEVEL</b>
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Citizenship responses to issues	X	X	X			X	X
Principles of citizenship action			X				

Methods of citizenship action			X		X	X
Individual vs Group Action		X	X		X	X
Guidelines for decision-making	X	X	X		X	X
Applying issue resolution skills	X	X	X	X	X	X

### Guidelines for the Curriculum Developer

Below, the writers have reproduced what can be considered as truly important guidelines or criteria that could help focus any environmental education curriculum development project. These guidelines were adapted from the Unesco-UNEP International Environmental Education Programme, Environmental Education Series 22, *Procedures for Developing an Environmental Education Curriculum*, pp 73-75. Using these criteria provide a great deal of power for the curriculum developer. The guidelines follow:

#### Planning and Development Guidelines

1. The curriculum developer(s) must know, before starting, what their philosophy is and what their goals must be. They must be able to identify and communicate their philosophical perspective and clearly understand what it is they want the learners to be able to do, to know, and to accomplish at the end of their contact with the curriculum.
2. The curriculum developer(s) must be willing and able to make instructional decisions which are consistent with carefully thought out and correctly sequenced goals. [Examples: Goals are inferred in the Tbilisi Objectives and are also operationally defined through the Goals for Curriculum Development found elsewhere in this document.]
3. The format for curriculum implementation must be decided in the beginning. It can be implemented as a single and separate subject or it can be implemented on an infusion basis. This decision will control how the curriculum looks but not the goals it addresses.
4. The developed curriculum must provide for the acquisition and transfer of critically important knowledge, skills, and attitudes. In order to succeed, the environmental curriculum must provide for both the acquisition and transfer of knowledge and skills by learners to situations both within the school and out in the community.
5. The curriculum developers must recognize that a variety of instructional models must be considered in any curriculum development process. Different instructional models are effective for different things and should be responsibly utilized. Relying only on one instructional model often dooms a curriculum to failure.
6. Curriculum development should enjoy the combined efforts of a variety of experts. Of course, curriculum and content specialists should coordinate the project but they should welcome input from other school personnel as well as from external consultants and a variety of community members. The environment is so broad a topic as to demand the help of a variety of experts.
7. Community and regional resources should be surveyed and inventoried for use in the program. A good EE curriculum will rely, in part, on the resources of the

community and region. These resources must be made accessible as part of the overall curriculum. In addition, the resources must be known to the teachers so that they will be utilized.

8. The completed curriculum must *not* be looked upon as "supplementary". There are numerous supplementary "curricula" available and some of them have been distributed worldwide. However, we know of no supplementary materials that have a scope and sequence that accomplishes the goals described elsewhere in this paper. Supplementary materials can be part of a curriculum but they must not be considered as a fully developed curriculum.

### **Implementation Guidelines**

9. The school or the agency responsible for the school must be willing and able to find the resources necessary to guarantee a successful implementation of the curriculum. Few preservice or inservice programs do a good job of preparing teachers to adequately use EE materials and, in particular, a curriculum that has scope and sequence. Therefore, the resources must be made available to prepare teachers to implement the curriculum.

10. In-school and out-of-school vested interest groups need to be made aware of the new curriculum and their support secured in order for the new curriculum to be successful.

### **Evaluation Guideline**

11. A comprehensive program for evaluating the EE curriculum is necessary to determine a number of needs. Among the reasons for having a comprehensive evaluation program are: (1) to measure the extent to which learners have acquired the knowledge, skills, and attitudes which are desired, (2) to measure the effectiveness of those who are responsible to teaching the curriculum, and (3) to determine the extent to which the curriculum needs revision.

### **Evaluating Learners' Issue Investigation Knowledge and Skills**

Evaluation is not now nor will it ever be a simple matter. Evaluation is a difficult process from start to finish, particularly when the educator desires to measure elements that go beyond the simple retention of facts and concepts.

This document will deal with three modes of evaluation: (1) the use of performance objectives in the skill development programme, (2) the use of a sophisticated evaluation instrument for measuring the entire gamut of skill development in a cognitive dimension, and (3) the use of a learning contract for the actual issue investigation.

Educators who use the issue investigation and evaluation approach, typically use learner (performance) objectives with their lessons. When learner objectives are

**. . . many objectives do not lend themselves to traditional forms of evaluation. Thus, new [evaluation] strategies are in order.**



well written, the evaluation takes on a one-to-one correspondence with the objectives itself. What is different about this mode of evaluation is the fact that many objectives do not lend themselves to traditional forms of evaluation. Thus, new strategies are in order. Below, the writers present a few examples of objectives which are actually used in the issue investigation and evaluation approach along with suggestions for the evaluation of them.

<b>The Objectives</b>	<b>Possible Evaluation</b>
1. . . . after reading a description of an environmental issue, correctly identify the research questions that apply to that situation from a list presented to you.	Present learners with a summary of a global change issue, present them with a list of research questions, and ask them to identify those that are consistent with the issue.
2. . . . after reading a description of an environmental issue, write research questions that are consistent with the issue.	Present learners with a summary of a global change issue, present them with a list of research questions, and ask them to identify those that are consistent with the issue.
3. . . . compare two information sources about greenhouse gases, identify the important data in each source and communicate how these data differ.	Present learners with two greenhouse gas information sources and ask them to identify important information in each and communicate specifically how these data differ.
4. . . . write a sample letter to an agency asking for information about a particular global change issue. The letter is to be correct in terms of general structure, the agency chosen to be contacted, and the kinds of information requested.	After teaching the skills associated with letter writing, assign students the task of selecting a global change issue, choosing an appropriate agency to write to for information, and preparing an appropriate letter. Evaluate the letter against the criteria stated in the assignment.
5. . . . write conclusions, inferences, and recommendations for real global change data.	Give learners an issue summary and allied data. Assign them the task of reading this information and preparing valid conclusions and inferences based on these data and, subsequently, recommendations that would be appropriate
6. . . . demonstrate the ability to graph scientific data related to a global change issue.	Present learners with a data set and assign them the responsibility of graphing it, using the "Rules for Graphing" which were presented and practiced in class.

There are times when an instructor, having finished with the skill development portion of the issue investigation and evaluation strategy, will want to conduct a comprehensive examination covering many of the key skills that have been taught. Doing this based on a real or surrogate issue is no small task. Such an instrument has been developed, however, and modified slightly for use in this document. It follows, along with responses that would be considered as correct during a grading of the instrument. Other responses, quite possibly, would also be correct and the instructor would have to make carefully thought out decisions regarding them.

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**A SAMPLE EVALUATION INSTRUMENT FOR  
ISSUE INVESTIGATION AND ACTION SKILLS WITH  
ACCEPTABLE (SAMPLE) RESPONSES**

Developed by Hungerford, Ramsey, and Volk, 1990

### A QUESTION OF PROGRESS

Recently the small eastern Illinois city of Ironton experienced a very real problem that dealt with a serious land use management question. A business developer approached Mr. Henry Tillman and offered to purchase eighty (80) acres of his farm in order to build a new shopping mall. Mr. Tillman's farm was the first one next to the city limits and offered an ideal location for a shopping center. The developer, Mr. Hank Smith, explained that he would be willing to pay up to one-million dollars (\$1,000,000) for the field. Mr. Tillman knew that the field was worth about \$50,000 on the open market as agricultural land. He decided to sell if the zoning regulations could be changed.

Getting an option on the land, Mr. Smith went to the zoning commission and requested that the zoning restriction be changed from "Agricultural" to "Commercial". He explained that the mall would bring millions of dollars to Ironton and encouraged additional commercial development on that side of town. In addition, he told the commission that many dozens of jobs would be created. The commission took his request under advisement and decided to act on it at its next regular meeting.

The *Ironton Daily News* published Mr. Smith's request the very next day and reactions were immediate. Several groups took exception to the proposed change in zoning. Others supported the development of the mall.

**The information above contains a global change issue. Please specify the exact issue that exists in that information. Do this in one sentence.**

Issue: *Should agricultural land adjacent to Ironton be rezoned for commercial development?*

The county agricultural association took exception to this use of the land, commenting that the area was losing far too much agricultural land to commercial and residential development. The Chamber of Commerce was pleased, citing continued development for the city. The local builders' union was also pleased and supported the rezoning of the

land. The union knew the value of construction jobs for its members. Residents on the side of town on which the mall would be located argued against the development, citing traffic congestion, increased crime, lack of privacy, and a number of other things which would be negative for family living. Members of the local Sierra Club were very disturbed because a rare natural area was close to Mr. Tillman's farm and additional development could jeopardize the well-being of this area. Mr. Tillman was interviewed by the *Ironton Daily News* and he told the reporter that the money would be great for his retirement. He also said that he should be able to sell his land to anyone he chose because it was his and he could do whatever he pleased with it.

**It is obvious that there is a global change issue here. A problem exists and it has become an issue. There are numerous "players" and all of the players have beliefs and values operating. Below, you will find a list of important players. For each player, you are to identify that player's belief and the most important value present in that belief. Some players may have communicated more than one belief.**

<b>PLAYER</b>	<b>THE PLAYER'S BELIEF</b>	<b>THE VALUE</b>
Mr. Smith	<i>Rezoning Encourages Development and Jobs</i>	Economic
Mr. Tillman	<i>I'll get more money if land is rezoned</i> <i>I can sell it if I want to. It's mine.</i>	Economic Egocentric
Co.Agr. Assn.	<i>The county is losing too much agricultural land.</i>	Conservation
Chamber of Comm.	<i>Development is good for Ironton.</i>	Economic
Builders' Union	<i>Construction is profitable for our membership.</i>	Economic
Local Residents	<i>The mall will decrease our quality of life.</i>	Social
Sierra Club	<i>Development threatens the nearby natural area.</i>	Ecological

Issue Information Continued:

One month after the initial proposal, the zoning commission decided to change the zoning on the land from "Agricultural" to "Business". Thus, the stage was set for the mall to be developed. Needless to say, some people were happy and some were very unhappy.

As soon as the zoning commission acted, the Sierra Club went into court and asked the County Judge for an injunction to prohibit the change in zoning. The Sierra Club argued that the shopping mall would endanger the rare natural area close to Mr. Tillman's farm and that the zoning commission had not taken this into consideration in making its decision.

**Let us assume that the judge issued the injunction asked for by the Sierra Club. There would, of course, be consequences. Please, describe the consequences of this action for each of the following categories:**

**Economic Consequences:** Negative economic consequences for Mr. Tillman as well as for the union members and Mr. Smith, the developer. All would lose additional income.

**Ecological Consequences:** The natural area would probably be saved, preserving the habitat that it provided. Also, the soil resources of Mr. Tillman's farm would be saved.

Assume that you were an interested citizen in Ironton. You discovered that others felt the same way about this issue as you do. Basically, you side with the Sierra Club because you do not like to see agricultural land or rare, natural areas threatened. What mode of action (other than legal) could you and your fellow citizens use in trying to help solve this issue?

**Action Mode:** Persuasion and/or political action.

What would be your best "action plan" for this mode of action? In a brief outline below, describe the "action plan" that you would propose in defense of the natural area and against development of the mall.

Students could respond in different ways. One appropriate response would be to organize a group of friends to: (1) write persuasive letters to the editor of the local newspaper for publication, (2) prepare petitions for submission to the zoning commission. Subsequently, the group could offer its services to the Sierra Club in the hope that a coalition of groups could have a greater impact on public opinion and, therefore, the zoning commission's eventual decision.

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Teachers are often concerned about how to evaluate students who are conducting full-blown issue investigations. One of the most promising strategies is to use a learner contract which specifies the criteria that will be used in the evaluation as well as the raw score points that will be assigned to each criterion. The contact below is a slight modification of one used in a number of schools in the U.S. The raw score points have not been included because different teachers will use different point values.

**Teachers are often concerned about how to evaluate students who are conducting issue investigations.**

The issue investigation, being a major undertaking, needs to be evaluated thoroughly. Seldom do secondary school students have an opportunity to undertake such an assignment and, as such, it should be treated as a major assignment. The contact is one evaluation mechanism that will accomplish this.

## GLOBAL CHANGE ISSUE INVESTIGATION CONTRACT

Student: \_\_\_\_\_ Teacher: \_\_\_\_\_

Title of Issue Investigation: \_\_\_\_\_

I hereby contract with my instructor that I shall use all my intellectual ability and those skills which I have learned in order to successfully investigate the global change issue chosen. Further, I guarantee that my independent investigation will be conducted in a manner as to give me pride in myself and to respect the rights of others.

I understand that my research will be evaluated on a raw-score basis and that my final grade for this project will be based on the number of points earned. Further, I have read the following breakdown of criteria and understand how I will be evaluated.

Criteria	Possible Points	Earned Points
Quality of the research question(s)	_____	_____
Techniques used in the investigation	_____	_____
Seriousness of approach to research	_____	_____
Quality of data collected	_____	_____
Accuracy of conclusions	_____	_____
Quality of inferences	_____	_____
Quality of recommendations	_____	_____
Accuracy and organization of final report	_____	_____
Development and evaluation of an action plan	_____	_____
Class presentation	_____	_____
Other _____	_____	_____
<b>Grand Total</b>	_____	_____

\_\_\_\_\_  
Signature of Student

\_\_\_\_\_  
Signature of Teacher

\_\_\_\_\_  
Witness

\_\_\_\_\_  
Date

## **APPENDIX A**

### **Producing a Global Change Issue Case Study Livestock Farming**

## Producing a Global Change Issue Case Study: Livestock Farming

**Ubiquitous and familiar, livestock exert a huge, and largely unrecognized, impact on the global environment.**

David H. Wright, 1990

The development of a case study which focuses on a specific global change issue necessitates following the four goal level model described elsewhere in this document. This means that indepth instruction must take place on: (1) content foundations, (2) issue awareness, (3) issue investigation, and (4) citizenship action. It is important to remember that any global change issue-related case study would basically follow the same format.

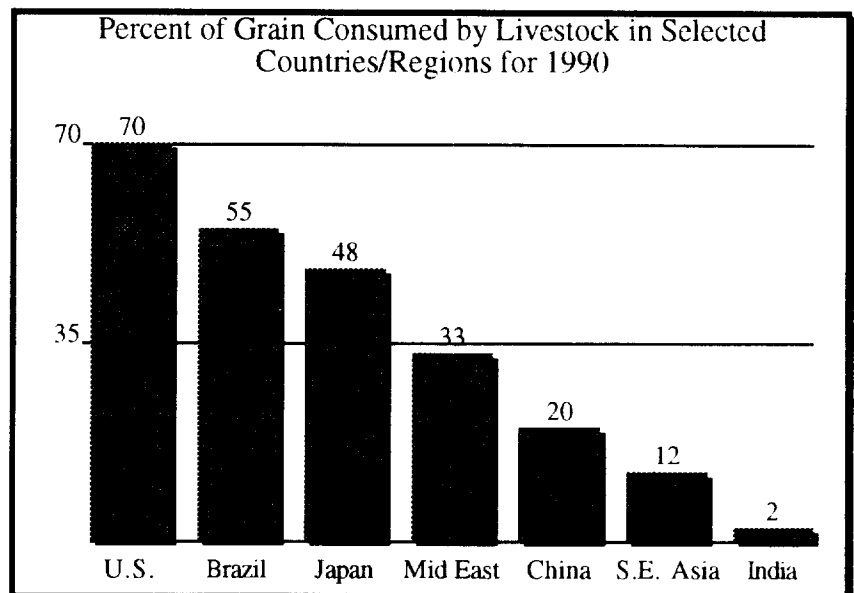
This section presents an abbreviated display on the development of a case study focused on animal farming, one issue which has important implications for global change but an issue which is largely overlooked in schools. An outline of the case study contents can be found on the following page. Below can be found sample entries that could be used in the development of such a case study.

### GOAL LEVEL I: CONTENT FOUNDATIONS LEVEL

#### Sample Learner Objectives:

Upon completion of Level I activities, the learner will be able to . . .

1. . . . compare animal protein consumption in developed and developing countries.
2. . . . describe how cattle farming contributes to global warming via methane production, tropical rainforest destruction, and the carbon released as fuels are burned in the farming operations.



3. . . . infer why residents of the U.S. and Australia, for example, consume far more red meat than those of India and/or China.

**Sample Outline for a Global Change Case Study:  
Livestock Production and Consumption**

**GOAL LEVEL I: CONTENT FOUNDATIONS LEVEL**

Teacher Notes

Learner Objectives

Knowledge (Content) Associated with Animal Farming

Student Activities

**GOAL LEVEL II: ISSUE AWARENESS**

Teacher Notes

Learner Objectives

Identifying Problems and Issues Associated With Animal Farming

Analyzing Related Animal Farming Issues for Positions, Beliefs, and Values

Using Secondary Sources for Obtaining Information on Animal Farming Issues

Comparing Animal Farming Information Sources for Content and Bias

Producing an Issue Web for Animal Farming and its Global Implications

**GOAL LEVEL III: ISSUE INVESTIGATION**

Teacher Notes

Learner Objectives

Writing Research Questions for Animal Farming Issue Investigation

Using Primary Sources for Obtaining Animal Farming Issue Information (Data)

Developing and Using Surveys, Questionnaires, Opinionnaires, and Interviews

Data Interpretation Skills

Conducting a Local Indepth Animal Farming Issue Investigation

**GOAL LEVEL IV: CITIZENSHIP ACTION**

Teacher Notes

Learner Objectives

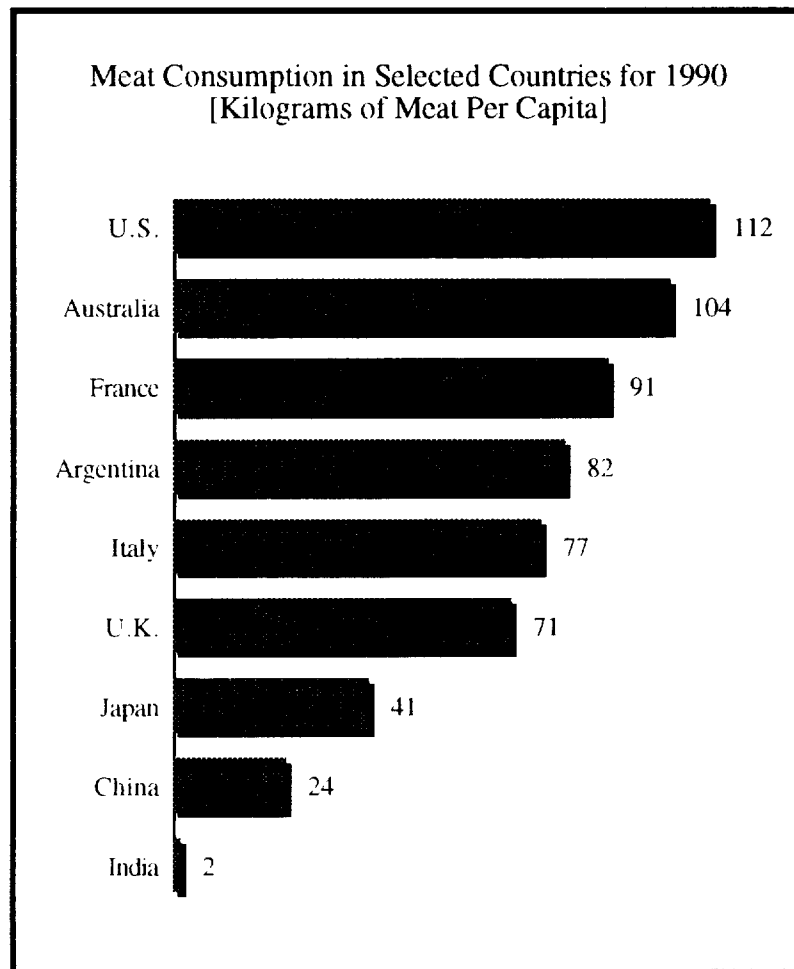
The Modes of Citizen Action

Making an "Action Plan" (Planning for Action)

Evaluating an "Action Plan"

Taking Action





**Sample Foundational Knowledge (Concepts)  
Associated with Animal Farming**

1. High red meat consumption appears to be related to a number of serious health problems including heart disease and some forms of cancer.
2. Extensive livestock production has serious environmental side effects.
3. Pork production absorbs more grain worldwide than any other livestock industry. Next in line is poultry production. Together they account for at least two-thirds of feed grain consumption.

**Sample Student Activity for the Foundations Level:**

Assign students the reading of "Fat of the Land" by Alan B. Durning in *World Watch*, 1991, Vol. 4, No. 3, pp 11-17. Working alone or in small groups, ask students to prepare a written or oral synthesis of this article. Subsequently (and using other sources the students may secure), assign the task of preparing lists of major negative health impacts from livestock farming and major negative environmental impacts from livestock farming.

## GOAL LEVEL II: ISSUE AWARENESS

### **Sample Learner Objectives for the Issue Awareness Level:**

Upon completion of Level II activities, the learner will be able to . . .

1. . . . successfully identify the beliefs and values underlying specific positions (pro and con) regarding livestock production around the world.
2. . . . identify key players operating in beef production in his/her own nation or in another selected by the instructor.
3. . . . read and report on several secondary information sources, responsibly examining each for bias.
4. . . . develop or help develop an issue web surrounding livestock production, accurately identifying ancillary but significant environmental issues associated with livestock farming, e.g., methane production, energy consumption, land degradation, rainforest destruction, carbon production, etc.

### **Sample Knowledge (Concepts) Associated with Animal Farming Issues [debate may result from disagreement on some of these concepts]:**

1. Human beings everywhere can help reduce the demand for livestock production by adjusting their diets.
2. Where forests are cleared for cattle ranching, the diversity of life suffers dramatically. It is estimated that, although tropical forests cover only 7% of the land, they harbor half of the world's species of plants and animals.
3. The modern demand for meat can no longer be sustained by traditional livestock production systems, e.g., using grass and crop residues instead of energy intensive strategies relying on grain and indoor feeding facilities.
4. Dramatic numbers of domestic animals around the world give off millions of tons of methane annually. This methane, a greenhouse gas, significantly contributes to climate change.

### **Sample Student Activity for the Issue Awareness Level:**

Assign students the task of researching the pros and cons associated with livestock farming and, concurrently, identify the important players involved (e.g., ranchers, feed lot operators, fast food corporation executives, beef/poultry consumers, indigenous tribesmen, tropical forest ecologists, soil scientists, range managers, etc.) and their positions on the current status of livestock farming as well as the beliefs and values which underly these positions.

### **GOAL LEVEL III: ISSUE INVESTIGATION**

#### **Sample Learner Objectives for the Issue Investigation Level:**

Upon completion of Level III activities, the learner will be able to . . .

1. . . . communicate the differences that exist between opinionnaires, questionnaires, and physical surveys.
2. . . . write valid research questions for the investigation of a specific livestock farming issue.
3. . . . prepare questionnaires or opinionnaires which will answer important research questions.
4. . . . scientifically interpret data collected during a livestock farming issue investigation.

#### **Sample Student Activity for the Issue Awareness Level:**

Using a student-developed or teacher-developed survey instrument, have the students investigate a livestock farming issue which is, in some important dimension, related to global change. Said investigation could be conducted by small groups of learners, individuals, or by the class as a whole. This would be up to the instructor to determine. Regardless of the mode of investigation, the investigation should be empirically designed and the samples to be surveyed carefully selected.

[**Note:** This case study development section of the document focuses on livestock farming in a generic sense. However, it is very difficult to investigate the overall, generic issue. The case study which is developed should most probably be restricted to a small group of subordinate issues or a single subordinate one, e.g., the production and expulsion of greenhouse gases from ruminants. In addition, the investigation should focus on the issue in a local or regional dimension.]

### **GOAL LEVEL IV: CITIZENSHIP ACTION**

#### **Learner Objectives for the Citizenship Action Level:**

Upon completion of Level IV activities, the learner will be able to . . .

1. . . . communicate the modes of citizenship action and describe how they differ from each other.
2. . . . prepare an "action plan" for helping resolve a livestock farming issue using information collected during the issue investigation itself.
3. . . . communicate the results of an evaluation of the previously developed "action plan".
4. . . . successfully implement the "action plan" if the learners choose to implement same.

**Sample Student Activity for the Citizenship Action Level:**

Once an "action plan" has been developed, assign learners the task of evaluating the plan using the following worksheet. This evaluation does several important things: (1) it teaches the necessity for evaluating actions citizens wish to take, (2) it actually evaluates the efficacy of the original "action plan", and (3) it helps students decide if they want to implement the plan if it can be shown to be effective and logical.

**Action Plan Evaluation Worksheet**

1. To what extent is there sufficient evidence to warrant action on this issue? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
2. Are there alternative actions available for use? What are they? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
3. To what extent is this action the most effective one available? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
4. What are the legal consequences of this action? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
5. What are the social consequences of this action? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
6. What are the economic consequences of this action? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
7. What are the ecological consequences of this action? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
8. To what extent do my personal values support this decision? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
9. What are the beliefs and values of others involved in this decision? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

10. Do I understand the procedures necessary to take this action? Yes \_\_\_\_; No \_\_\_\_.
11. Do I have the skills needed to take this action? Yes \_\_\_\_; No \_\_\_\_.
12. Do I have the courage to take this action? Yes \_\_\_\_; No \_\_\_\_.
13. Do I have the time needed to complete this action? Yes \_\_\_\_; No \_\_\_\_.
14. Do I have the other resources needed to complete this action effectively? Yes \_\_\_\_; No \_\_\_\_.

Taking into account the answers to the above questions, state your final recommendations for action. Exactly what is your plan? Will you try to complete it?

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**END OF LIVESTOCK FARMING CASE STUDY EXAMPLE**

## **APPENDIX B**

### **Teaching About Global Change: Issue Investigation and Evaluation**

## Teaching About Global Change - The Issue Awareness Level

### An Introduction to Environmental Problem Solving

In Part II a great deal of information was presented pertaining to global change issues. Much of this could be used as a basis for the Foundations Level in global change education. For each of the global change topics or issues, data were reviewed regarding ecological implications for the biosphere. In addition to the ecological implications of global change, material in Part II analyzed the human aspect of each issue. This analysis included how individual humans contributed to global warming, deforestation, land degradation, and so on.

When these relationships are investigated with students, we enter into the issue awareness level of global change education. At this level we are looking at the **relationships between humans and the environment**. We will define environment as being made up of all the objects and events in the universe (both living and non-living) plus all of the interactions taking place between those objects and events.

As discussed in Part II of this document, humans are constantly interacting with the global environment. Each of the 5,000,000,000 plus individuals on this planet constantly interact with the environment. We will define **environmental interaction** as the use of a resource from the environment for a specific purpose. This could be activities such as taking oxygen from the atmosphere to breathe and exhaling CO<sub>2</sub>, or it could involve events such as extracting minerals from the earth or removing fish from a marine ecosystem. In any event, it should be evident that we are constantly interacting with the environment.

To get a sense of the complexity of the outcomes of these actions let us take a look at one basic human function known throughout much the world.

#### Growing and Consuming Rice

Hundreds of millions of people in the world rely on rice as a food staple. The environmental interactions that can take place to produce, harvest, and prepare the rice are:

- Clearing land to create rice paddies.
- Diking and damming water for needed moisture.
- Energy inputs of various kinds for growing and harvesting.
- Transporting rice to market [or processing plant].
- Resource use for packaging or bagging rice for human consumption.
- Energy inputs for cooking rice.

These are just a few of the interactions humans have with the environment when we grow and consume rice. But what are the effects of these interactions to the parties involved: humans and the biosphere?

#### Humans

Supplying vital energy for survival.  
Providing jobs for human beings.  
Providing feed for domestic animals.  
Supporting local/national economies.

#### Biosphere

Loss of natural ecosystems.  
Altering/disrupting wetlands.  
Increase of greenhouse gases (e.g., methane, carbon).

It is important to note the disparity between the effects on humans and those on the biosphere, of producing and eating rice. The growing, harvesting, distributing, and consuming of this product typically bodes well for most humans. On the other hand, many of these interactions related to rice production adversely effect the biosphere. This is only one of many cases where environmental interactions tend to increase quality of life while decreasing the quality of the biosphere.

Many of these interactions can result in what are termed **environmental problems**. An environmental problem occurs when a human interaction causes some sort of negative impact on surroundings, and possibly on the people involved. For example;

A large farm practices intensive agriculture adjacent to a large river. When rain falls in the spring, much of the fertilizer used to enrich the soil is washed into the waterway. The collection of nitrogen and other chemicals from the fertilizer kills a chemical-sensitive fish that lives in this stream.

The practice of farming is an excellent example of how humans interact with the environment. We are using soil, land, water, and sunlight to produce food. This interaction, in this case, is causing a negative effect on the bordering waterway. Hence, the runoff of fertilizer into the river is an environmental problem.

In the above example, there was no question that the fertilizer runoff was impacting on the aquatic life in that river. However, as discussed in Part II, many environmental problems spawn a myriad of questions and debate. It may be disagreement over the magnitude of certain problems, the sources of the problems, or even solutions to those problems. In any event, there is usually some degree of debate associated with these problems. These disagreements can be defined as **environmental issues**. One environmental problem can spawn a variety of environmental issues. For instance, let's see what kinds of issues could form from the farm-fertilizer runoff scenario.

#### **Environmental Problem**

Fertilizer runoff resulting in the fish kill.

#### **Possible Issues**

Effect of fish kill on the ecosystem . . . impact of the loss of the species itself . . . economic benefits of using chemical fertilizers verses not using them . . . the effect of chemical fertilizers on nonrenewable resources . . . the alternative solutions to the issue . . . individual rights vs governmental rights and responsibilities.

This one problem could result in numerous environmental issues. As one can see, environmental problems and the issues associated with them can become very complex. Many issues are not disagreements that have only two sides - they tend to be more complicated than that!

In the next section of this document, we will review steps that can be taken to analyze these issues so that both the teacher and the student can gain a better understanding of the issues and not be intimidated by them. Before we do that, however, a connection with global implications is in order.

Do environmental problems and issues, such as the example above, become global concerns? As discussed in the first and second part of this text, the individual can and



does make a global impact. Therefore, it would stand to reason that many interactions with the environment could become global problems and hence possible global issues. To exemplify this let us take a look at one agriculture-related situation. The illustration on the following page presents a brief analysis of a specific human-environment interaction . . . the consumption of bread, a grain product. The diagram presents a number of human activities involved in the production of that food staple, and then illustrates a number of negative impacts those activities can, and often do, have on the environment.

In a sense, eating bread contributes to a number of major global change issues. The very things we take for granted, like eating a piece of bread, can and do have implications for the world community. The point of this analysis is not to confront the reader with the negative impact we can have on the earth. On the contrary, this exercise is meant to exemplify the connections each individual has with the global environment. In turn, these connections provide the possibility for an array of global change problems and issues.

### **Analyzing Global Change Issues**

Each interaction with the environment can be negative or positive. Each negative impact can produce an environmental problem. These problems are laden with issues that can have global implications. Therefore, the world community is constantly engaged in a myriad of global problems and issues. It is understandable that most of the earth's inhabitants are unaware of many of these issues and, if aware, are uninformed of their complexities. These global change issues are not polarized debates. Rather, they are complex concerns that harbor positions, opinions, fact, fiction, and even intrigue.

The best we can do is attempt to understand these global issues as thoroughly as possible. The ability to analyze and understand these concerns may then provide the learner with his/her own conception of the problem and issues. This understanding will hopefully dispel some of the anxiety and hesitation associated with these issues; attitudes that tend to impede an individual's interest and possible involvement in these global concerns. Therefore, this section will attempt to outline strategies that can be utilized to help the learner understand global issues and to be able to make responsible judgements about them.

In analyzing global change issues, answers are needed to several questions. Below are some of these inquiries:

- \* What is the environmental problem(s) associated with this global change issue?
- \* What is the global change issue in question? In other words, what is the disagreement about?
- \* Who are the individuals and/or groups involved with this issue?
- \* What are the positions on the issue held by these groups and/or individuals?
- \* What are the beliefs held by these groups and/or individuals?
- \* What are the values held by these groups and/or individuals which underlie these beliefs?

**GLOBAL CHANGE INTERACTION**

The Need for Bread as a Food Staple



The Demand for Wheat to Supply This Staple



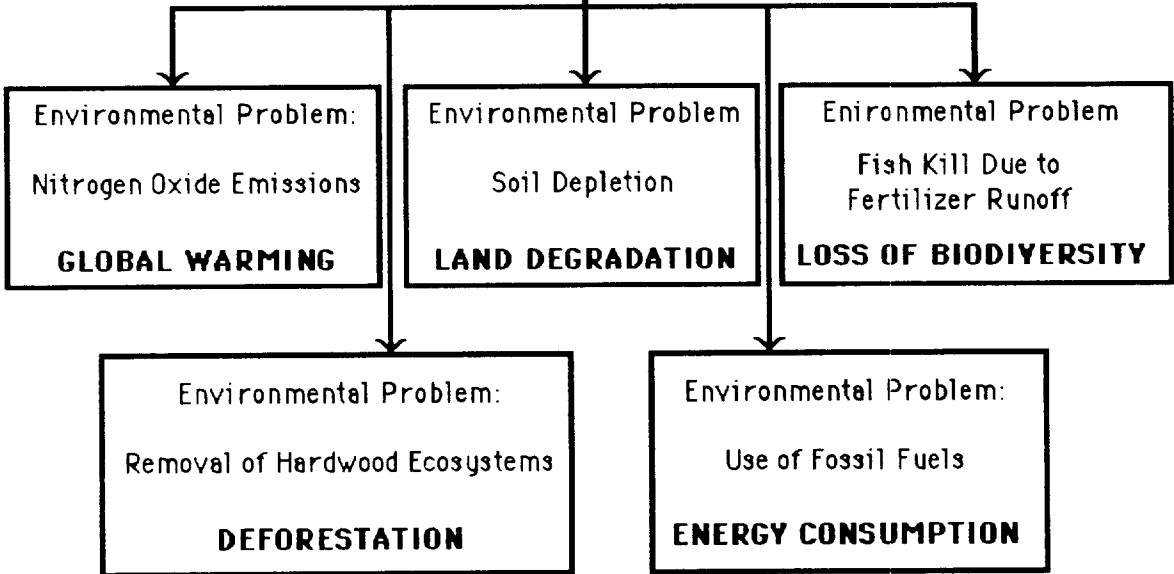
Clearing Natural Ecosystems for Cropland



The Application of Chemical Fertilizers to Boost Wheat Production



Energy Expenditures for Planting, Harvesting, and Transportation



The demand for bread as a food staple results in many environmental interactions, some of them decidedly negative in ecological terms. Further, a close inspection would reveal that the above examples are only a sampling of those that might apply to this particular scenario.

The nature of these questions and the processes involved in answering them will be addressed through the analysis of a global change issue. Below is a summary of an important global change issue that was described in Part II.

### **Deforestation in Malaysia**

In the heart of the Borneo rainforest in Malaysia lies the province of Sarawak. Due to its location in one of the most productive forests in the world, Sarawak is the largest source of unprocessed tropical timber on the international market. In fact, it dominates the world market in hardwood logs, exporting approximately 15 million cubic meters a year. Sarawak's Minister of the Environment is James Wong who pioneered the timber industry in Malaysia. He believes the industry is good for his country. He states, "All the animals and birds are back. . . . with more fruits and nuts than before. . . . logging is good for the forest."

The Sarawak is home to several aborigine tribes including the Penan, Kelabit, Kayan, and Iban cultures. In the early 1980's, these tribes began to witness large scale clearing of tropical forests by the timber industry. The destruction of vegetation has had a great impact on the local tribespeople. As one elder from the Penan described it, "Extraction of timber has caused extensive and irreparable damage to the natural land surface and vegetation....having a devastating effect on the community."

Beginning in 1986, the tribespeople began to protest the logging. Many of these people claimed that the government's forestry practices were poorly managed and caused a great deal of damage. As one native remarked, "The Sarawak forestry industry is performing hit-and-run logging . . . the primary forest will be finished in seven to eight years." The government disagreed and has claimed that it is promoting a conservation ethic. Government leaders also pointed to a series of projects that they feel are conservation oriented.

As the protests continued, the tribespeople sought help from the international community, in particular environmental groups such as Friends of the Earth. This involvement on the part of the international community antagonized the Malaysian government and motivated the recent organization of a global campaign to discredit the environmentalists. The Secretary-General of the Foreign Ministry, Ahmad Kamil Jaafar, reported that seminars will be held to address the "baseless allegations" of the conservationists who say Malaysia's forests are being destroyed. As of press time the debate on the Sarawak forests continues.

(Magistad, 1990; Pearce, 1990; Rubeli, 1989)

This brief summary illustrates the complexities of global change issues. It therefore makes sense to utilize the questions presented earlier to help guide the learner in the analysis of this issue.

*What is/are the environmental problem(s) associated with this issue?*

The definition of an environmental problem stipulates that something be at risk in an interaction between humans and the environment. It is safe to say that the clearing of tropical forests does have a negative impact, not only on the ecosystem, but the local people as well. Therefore, the environmental problem is the impact of deforestation on both human and ecological communities.

*What is the issue?*

As was discussed earlier, an issue arises when there is a disagreement pertaining to the nature or solution of a problem. In the Malaysian case study, there are debates between tribal groups and the government about the effect of cutting the tropical forests, and about the practices performed in harvesting this timber. The issue, then, focuses on whether or not the Sarawak forests should be timbered.

*Who are the individuals/groups (the players) involved with the issue?*

- Minister of the Environment - James Wong
- The Sarawak aborigines
- A Penan elder
- A native spokesperson
- Foreign Minister - Ahmad Kamil Jaafar

*What are the positions held by these players on the issue?*

The players' positions on the issue, as stated in the summary, are:

The Players	Their Positions
Minister of the Environment - James Wong The Sarawak aborigines A Penan elder A native spokesperson Foreign Minister - Ahmad Kamil Jaafar	For timbering Against timbering Against timbering Against timbering For timbering

*What are the beliefs held by these groups and/or individuals?*

In analyzing an issue, it is important that the learner has concrete evidence pertaining to the beliefs/opinions of the players. It is critical that students accurately identify the players' beliefs. Actual quotes from individuals or official statements are the most prudent data to use in identifying beliefs. The beliefs of several players are identified below.

1. The following quote by Environment Minister James Wong states his belief regarding the issue.

"All the animals and birds are back....with more fruits and nuts than before.....logging is good for the forest."

2. This statement made by a Penan elder identifies his belief about the logging practices in the Borneo rainforest.

"Extraction of timber has caused extensive and irreparable damage to the natural land surface and vegetation....having a devastating effect on the community."

3. This belief put forth by a native Malaysian reflects his animosity toward the forestry management practices of the Sarawak timber industry.

"The Sarawak forestry industry is performing hit-and-run logging...the primary forest will be finished in seven to eight years."

*What are the values held by these groups and/or individuals which underlie these beliefs?*

This aspect of global change issue analysis investigates why the players hold the beliefs they do regarding the issue. Again, it is prudent to review each statement and attempt to conclude as best we can the reasons for the belief.

"All the animals and birds are back. . . .with more fruits and nuts than before. . . . logging is good for the forest."

We do not know for certain but it seems that James Wong, at least in regards to this remark, believes that the logging can actually help the forest ecosystem. In this particular case we are forced to conclude that his statement was made based on an ecological value.

"Extraction of timber has caused extensive and irreparable damage to the natural land surface and vegetation....having a devastating effect on the community."

The Penan elder, although on the opposite side of the issue, makes a statement that is rooted in ecological and environmental values. Note that players on both sides of this issue have used ecological values to defend their belief statements.

. . . seminars will be held to address the "baseless allegations" of the conservationists who say Malaysia's forests are being destroyed.

This is a good example of a political value underlying a belief statement. The Secretary-General of the Foreign Ministry Ahmad Kamil Jaafar said

Several important definitions will aid the learner in analyzing issues. As discussed previously, the Malaysia scenario included a global **environmental problem** and a global change **issue**. It also included individuals and groups involved in the issue . . . these are defined as **players**. Their stances on the issue (where they stand on the issue) will be termed **positions**, while the statements defining their positions are termed **beliefs**. (A belief is an idea which a person holds to be true.) Finally, the reasons for their beliefs and the implied meaning behind these belief statements are closely related to the individuals' **values**. (A value is the worth a person places on something.) An individual's values provide the foundations for his or her belief statements. On the following page can be found a table which will present the full issue analysis of the Malaysian scenario, utilizing the above terms.

### Global Change (Sarawak Timbering) Issue Analysis

The Problem: Tropical deforestation impact on human and natural communities.

The Issue: Whether or not the Sarawak forests should be timbered.

Players	Positions	Beliefs	Values
James Wong	For the logging.	Logging is good for the forest.	ecological
Penan elder	Against the logging.	Timbering has caused extensive damage.	ecological
Malay native	Against the logging.	at the present rate of logging, the forest will be finished in seven to ten years.	environmental
Ahmad Jaafar	For the logging.	Allegations by environmentalists are baseless.	political

## Teaching About Global Change - The Investigation and Evaluation Level

### Selecting Research Questions

The analysis of the Malaysian timbering issue should reinforce the idea that global change issues can be very complex. There are clearly a number of players, positions, and beliefs that can emanate from one environmental problem. To reduce the complexity and better grasp the issue, a student can analyze the issue using the sequence of questions presented in the previous section. These questions help organize and clarify complex global issues.

What if a student or class wants to learn more about a particular global issue than just the classification of the players, positions, and their beliefs? Specific global change issues may capture student interest . . . still others may be of a critical nature and demand further investigation! In either case, when it comes to issue investigation, an important initial step must be taken - asking more questions.

All science starts with questions. Answers to these questions are sought by collecting related data and interpreting it. Questions supply the focus and guide the processes that follow. This is also the case in issue investigations. Questions guide investigations by providing a direction. To a large extent, questions also control what happens in the investigation. Thus, **research questions** are an important first step in investigating and evaluating global change issues.

In order to illustrate the generation of research questions we will look at another global change issue. Below is a brief review of the Krakow vignette.

### **The Lenin Steel Works**

Just outside of Krakow, Poland's third largest city, sits the Lenin Steel Works. The mammoth facility looms over the surrounding countryside dumping out tons of smoke and carbon dioxide a year. Krakow's air has been heavily polluted by completely unregulated heavy industry and by low quality coal. The fallout from this air pollution has had an effect on the local children. The local public health department reported that during a four year period, sixty-one percent of the children surveyed had been under doctor's care for chronic illness related to air quality. As one health official stated, "It seems that people in Krakow are sicker than those in other parts of the country."

Although this may seem to paint a bleak picture, the future of the town and its air pollution problems may see brighter horizons. Since the demise of the previous government, Poland is experiencing a growth of environmental concern and responsibility. For example, the public health department is already embarking on a five year study of local residents and their physical reactions to air pollution. Other movements include the increased role of the Krakow Department of Environmental Protection. The agency is attempting to force the steel mill to reduce its emissions. The government has aided in this quest by declaring Krakow an "especially protected area". The results have been encouraging. The mill will cease processing its own coke, pig iron, and lime which should reduce emissions by thirty-five percent.

The growth and resurgence of local interest in environmental issues in Krakow and the rest of the country has faced resistance. With the obvious fluid nature of the government and the economy, other concerns are being forced to the foreground. One in particular is the economic stability of Poland. Lech Jeziorny, vice chairman of the Krakow Industrial Society, believes that money is the most important barrier to Poland's environment. He acknowledges this when he talks about the fate of the 30,000 workers employed at the Lenin Steel Mill, "The question is what to do with the workers, with the firms, with everything. Ecology cannot exist without economy"

(Sweeney, 1991)

One of the issues which present in the above situation is:

How much environmental regulation (pertaining to the Lenin Steel Mill) should occur, (in light of the need for a stable Krakow economy)?

If a student decides to begin an investigation on this issue he or she will need to generate research questions to help guide the research. The variables involved in this issue will be utilized to form research questions. Variables are specific factors or conditions that are a part of the issue. Listed below are important variables associated with the above issue:

- The health of the Krakow population.
- The economic stability of Krakow.
- The beliefs about environmental regulation.

Using these variables, the following research questions might be formulated:

1. To what extent would reduced emissions from the Lenin Steel Mill result in healthier Krakow children?
2. To what extent does the Lenin Steel Mill affect Krakow's economy?
3. What are the beliefs of Krakow residents concerning environmental regulations of the Lenin Steel Mill?

These research questions related to the Lenin Steel Mill issue can be used to start and guide issue investigations. They were derived by: (1) stating the issues; (2) identifying the variables within the issue; and (3) using the variables to write research questions.

### **Research Question Rules**

There are several important rules for writing research questions for global change issue investigations. Research questions . . .

1. . . . are always *stated in question form*.
2. . . . always *avoid simple "yes" or "no" responses*. This is usually achieved by beginning with phrases such as "To what extent" and "In what ways".
3. . . . always *indicate a population or area*. The population refers to a group on which the research question is focused, e.g., residents of Mexico City, automobile users in Peking, etc. The area refers to the geographic area in which the population is located, e.g., Midwestern states of the U.S.A., Penan River Valley, Dewey Elementary School, etc.
4. . . . are *derived from global change issues and are related to global change issues*.
5. . . . when possible, *specify the variables to be measured*. A variable is a given factor or condition, e.g., knowledge of ecology, attitudes toward land use practises, beliefs about family planning, etc.
6. . . . when possible, *specify a relationship between two variables*. The following question seeks to find the extent that one variable (knowledge of ecology) affects another (attitudes fishing regulations): To what extent does ecological knowledge affect the attitude of commercial fishermen toward the fishing regulations?



## Collecting Information Aimed at Answering Important Research Questions

When the students have constructed their research questions, they can begin to gather background information regarding the issue. Among the information sources typically used are the following:

**Primary Data:** Primary data sources are used when the researcher goes out and obtains first-hand information. Primary data sources include interviewing experts or key players in an issue. For example, if a person wished to investigate stack emissions from a local electric generating plant, he/she might wish to interview public officials responsible for monitoring such emissions. In so doing, the learner is collecting primary data.

**Secondary Data:** Another way to get information about a global change issue is to use what are called secondary sources. Secondary sources include research reports, books, newspapers, and magazines, maps, and photographs. If a student wished to collect information on the ozone layer over the South Pole, he/she would probably find it difficult to travel there and make first-hand observations. Thus, the researcher would have to rely on information which others have produced. Because this information is obtained second-hand (from someone else's observations), it is often called secondary data.

**Combination (primary and secondary):** The third source of information would be a combination of the two others. With many issues (and research questions), this is not only possible, it is highly recommended. For instance, if a student wanted to investigate the land reclamation practices following coal strip mining, he/she would want to check the reclamation laws and regulations and write to and interview experts. The researcher would also want to investigate practices first-hand in the surrounding region if at all possible.

## Instruments for Primary Data Collection

The ability to obtain primary (first-hand) data is a skill that secondary school students should acquire at one level or another. In order to collect these kinds of data, several different methods are available. Among these methods are the use of surveys, questionnaires, and opinionnaires.

**Surveys:** This is a data collecting method that provides exact information. Surveys are often used to collect information about the physical environment. Some survey examples include:

- The amount of land in a country that is used for agriculture, forestry etc.
- The human population distribution in a region or country.
- The number of automobiles in a location that have air pollution devices.

**Questionnaires:** This method of information gathering collects factual information from people. The objective is to solicit objective data. Examples include:

- Amount of water consumed by family in a particular geographic area per week.

- Number of homes in which wood is used as a heat source.
- The extent to which adults look at the environmental voting records of political candidates prior to elections.

**Opinionnaires:** This information source is similar to the questionnaire in that it draws information from people. But this information is the people's beliefs or opinions.

- To what extent are farmers in the Ohio Valley in favor of economic incentives which would reduce soil erosion.
- To what extent do men in India believe that family planning centers should be available to adult females.
- Do residents of Mexico City believe that automobiles should be required to use an ethanol-mix gasoline.

### **Interpreting Data From Global Change Issue Investigations**

Up to this point, we have analyzed a global change issue and have constructed research questions which could serve as guides to learning more about an issue. We have also reviewed types of instruments that can be used to collect data to answer these questions. Once the data are collected, they must be interpreted. It is important for the researcher to take a conservative approach to data interpretation, particularly when inferences are being made.

Below are three important components of data interpretation:

**Conclusions:** A conclusion is an expression or statement of the end result. It is a statement of the actual outcome of one's data collecting. Conclusions do not explain an outcome, they simply report it. Below are an example of data collection and a conclusion.

**Data Collection:** A student in Nepal collects water samples from a local watershed. She finds that the samples contain heavy concentrations of silt.

**Conclusion:** The water flowing from the local watershed has a high concentration of silt.

**Inferences:** An inference is an assumption or judgement made from one or more conclusions. It is an explanation of the conclusion(s). Sometimes inferences are simply defined as explanations of observations.

**Inference:** Deforestation in the upper valley has caused a heavy concentration of silt in water flowing from the watershed.

**Recommendations:** A recommendation is advice given to a person or a group concerning some particular action or problem. For example, the student in Nepal might recommend that timbering practices in the upper valley be altered. She might also recommend that studies on the causes of soil erosion in that particular watershed should be undertaken.

## **The Independent Investigation of a Student-Selected Global Change Issue**

The steps that have been described in this section culminate in the actual investigation and evaluation of a global change issue. After students understand the steps involved in investigating issues (Hungerford et al., 1990), they are ready to choose their own global change issue. Students should be permitted to choose local, regional or global issues which interest and affect them. Below is a brief outline which describes the steps which might be taken in conducting a global change issue investigation.

### **A Procedure for a Global Change Issue Investigation**

- Step 1. Select an overall global change topic in which one is interested.
- Step 2. Conduct library research on the topic of interest.
- Step 3. Identify an important global change issue related to this topic and one which is researchable.
- Step 4. Critically analyze this issue, identifying important players as well as their positions, beliefs, and values.
- Step 5. Write research questions related to an important aspect of the issue.
- Step 6. Summarize the secondary information that has been collected.
- Step 7. Write letters to obtain information and interview resource people.
- Step 8. Develop, pilot, and revise an instrument (e.g., survey, questionnaire, opinionnaire) designed to collect data to help answer the research question(s).
- Step 9. Use instrument to collect data.
- Step 10. Organize the data into tables, charts, and graphs.
- Step 11. Interpret the findings making conclusions, inferences, and recommendations.
- Step 12. Produce a final written global change issue investigation report.
- Step 13. Present the results of the investigation to others.

### **Teaching About Global Change - The Issue Resolution Skills and Application Level**

It certainly would be safe to assume that a student who has successfully accomplished an investigation into a global change issue will be an "expert" on the topic. However, as Hungerford and Volk postulate (1990), the ownership of an issue is not the only important variable involved in changing environmental behavior. Research indicates that skill in using environmental action strategies is a major predictor of responsible environmental behavior. It is important, therefore, that we discuss strategies that acquaint and guide students in identifying citizen action(s) which might be appropriate for helping to

remediate specific global change issues, and in making decisions about becoming involved in issue remediation.

### **Types of Citizen Actions**

There are three major kinds of citizen action that can be taken on a global change issue. Everyday, every citizen around the world becomes involved in one or more of these kinds of actions. These are:

1. *Positive Action*:: This would be an action that helps improve or maintain the status of something.
2. *Negative Action*:: This would be an action that somehow harms the status of something.
3. *Passive Action*:: This could also be termed "no action". Passive actions are often thought to neither harm or improve the status of something. However, when too many people become passive about something, negative results can occur.

**Students have both rights and responsibilities when it comes to taking citizenship action with respect to global change issues!**

### **Principles of Environmental Action**

The following are important principles of citizenship action with which every secondary school student should become familiar. These principles focus on the rights and responsibilities associated with citizenship behavior in an environmental dimension.

1. You have a right to be heard and act upon global change issues.
2. You have the responsibility to exercise that right and to be knowledgeable and skilled in such actions
3. Some actions are mandated by law (e.g., permissible emission levels), but most involve your own choice of actions.
4. You have the ability to investigate global change issues and to obtain enough information on which to base a plan of action.
5. Most of the actions you take in your life have some social or environmental consequence. You have the responsibility to consider whether an action will be positive or negative over the long run.
6. You have the ability to become skilled in at least some of the methods of citizen action.

### **The Methods of Action**

If a student decides that they would be interested in pursuing action on a particular global change issue, they should be aware of the variety of action methods available to them. The available citizenship action methods will vary from society to society, and each

student should become familiar with the rights and responsibilities accorded to citizens in his or her nation. If we look to the citizenship action available in the United States, for example, we find that most of them can be grouped under four headings. These headings are:

**Action Method I - Persuasion:** *Persuasion is used when one person (or a group of people) tries to convince others that a certain course of action is correct. How many times in your life have you tried to convince someone that your position is the right position? This takes persuasion to be effective, particularly if that person or group chooses to disagree.*

**Action Method II - Consumer Action:** *Consumer action relies on the power of the pocketbook or billfold. It involves buying something that agrees with one's philosophy or not buying something that represents an action or an idea one disagrees with. Consumer action is particularly effective if a large group of people get together to take action. Even so, some individuals act alone in this dimension. Examples of consumer action? (1) Refusing to buy from fast food restaurants which use styrofoam food containers. (2) Refusing to purchase goods manufactured in a foreign country which has a negative environmental policy. (3) Buying products made by companies who try to reduce environmental pollution.*

**Action Method III - Political Action:** *Political action refers to any mode of action that brings pressure on political or governmental agencies and/or individuals in order to persuade them to take positive citizen action. In democratic nations, political action usually means supporting candidates who have positions similar to your own. It means pressuring people in governmental positions with letters, telegrams, and phone calls. It means casting a vote for or against a particular issue . . . and more.*

**Action Method IV - Physical Action (Ecomanagement):** *Ecomanagement is simply a word used to describe any physical action taken with respect to the environment. It can be illustrated by examples ranging from utilizing an emission control edvice on an automobile, to helping a private agency buy and preserve an ecologically-important forest. Ecomanagement results in either maintaining a good environment or improving a stressed one.*

## **Guidelines for Decision Making**

Once an action, or combination of actions, have been identified as appropriate for the remediation of a specific global change issue, a responsible citizen will carefully evaluate that action (or those actions). It is important to look closely at the resources needed to successfully carry that action to completion, and to examine the probable consequences of that action. This evaluation is a critical component of planning for responsible citizenship participation in the remediation of global change issues.

The authors have identified a total of fourteen questions which seem important to ask before proceeding with a citizen action. Carefully considered answers to the following questions will be most helpful in the decision on whether to initiate a particular plan of action.

1. Is there **sufficient evidence** to warrant action on this issue?
2. Are there **alternative actions** available for use? What are they?

3. Is the action chosen the **most effective** one available?
4. Are there **legal consequences** of this action? If so, what are they?
5. Will there be **social consequences** of this action? If so, what are they?
6. Will there be **economic consequences** of this action? If so, what are they?
7. What are the **ecological consequences** of this action?
8. Do my **personal values** support this action?
9. Do I understand the **beliefs and values of others** involved in this issue?
10. Do I understand the **procedures** necessary to take this action?
11. Do I have the **skills** needed to complete this action?
12. Do I have the **courage** to take this action?
13. Do I have the **time** needed to complete this action?
14. Do I have all the **other resources** needed to make this action effective?

It must be clear by now that if and when a student or group of students decides to take action on a global change issue there are always a large number of variables that must be considered. This is not intended to discourage students from taking action, but rather, to make them realize that issue resolution is an important undertaking. Finally, it is imperative to note that the student must make the decision as to whether they will take on this action. *The teacher should not influence the decision as to whether a student takes on an action or not.*

## GLOSSARY

**Abiotic:** nonliving; an abiotic variable in an ecosystem would be exemplified by such things as light, rain, moisture, heat, bedrock, and topography.

**Access:** to get; to secure, acquire.

**Acid rain:** Rainfall (or fog) which is more acidic than normal, often caused by an infusion of sulfur and nitrogen compounds from vehicular exhausts and coal burning power plants.

**Adaptation:** a particular attribute which contributes to an organism's survival in a community, e.g., protective coloration.

**Affective:** relating to feeling, emotion, or desire.

**Agrarian:** pertaining to farming, agriculture. An agrarian society is one in which the economy and culture are tied mainly to agricultural (rather than industrial) enterprises.

**Ancillary:** subordinate; of related but not of primary importance.

**Aquifer:** a place where water is found within the earth's crust (this water known as ground water).

**Arable land:** Land that can be cultivated to grow crops.

**Atmosphere:** layer of air surrounding the earth's surface.

**Autonomous:** independent, without outside control, self-regulating.

**Behavioral (in an educational context):** pertaining to actions of an individual, behaviors: often referred to in education as an action/behavior which is observable, overt.

**Belief:** that which a person holds to be true.

**Biodegradable:** any material that can be broken down in the environment by decomposers, e.g., paper products, human sewage, vegetable matter.

**Biogeochemical cycles:** those chemical cycles that are critical to the maintenance of ecosystems, e.g., nitrogen cycle, calcium cycle.

**Biomass:** plant materials and animal wastes used as fuels.

**Biosphere:** that relatively thin "shell" surrounding the earth that supports life.

**Carrying capacity:** Maximum population of a particular species that a given habitat can support over a given period of time.

**Chlorofluorocarbons (CFCs):** Organic compounds made up of atoms of carbon, chlorine, and fluorine.

**Citizenship action skills:** skills related to the actions and behaviors which citizens have at their disposal in working toward the solution of environmental issues.

**Clearcutting:** Method of timber harvesting in which all trees in a forested area are removed in a single cutting.

**Cogeneration** (of energy): producing two forms of usable valuable energy from the same process, e.g., electricity and heat being produced in the same process.

**Cognitive:** related to the mental processes by which knowledge is acquired; cognitive may relate to either an individual's knowledge or an individual's ability to process knowledge.

**Community:** in an ecological sense, an interacting and interdependent set of plants and animals, e.g., a prairie community, a pond community.

**Composting:** the process of speeding up the decomposition of organic debris such as leaves and vegetable wastes in order to produce material that can be used as humus or fertilizer.

**Conceptual:** relating to mental images held by individuals and associated with events and objects; ideas.

**Conservation:** Wise use of natural resources.

**Consumer action:** an economic threat by an individual or a group aimed at some form of behavior modification in business or industry, e.g., boycotting, discriminating and conservative use of goods and services.

**Consumption overpopulation:** the use of resources at such a high rate that significant depletion, pollution, and environmental degradation occur.

**Contingency:** an adjunct or accessory; a contingency plan would be a plan that could be substituted for the primary one.

**Criteria:** standards; rules by which something is judged or evaluated.

**Critical thinking skills:** those mental processes which enable a human being to process information in logical ways; cognitive problem solving skills; science and social studies process skills are critical thinking skills.

**Deforestation:** removal of trees from an area without adequate reforestation.

**Demographic:** relating to populations and the study of them, e.g., births, deaths, marriages, health, etc.

**Desertification:** the conversion of a productive ecosystem to desert through overgrazing, prolonged drought, or climatic change; often associated with man's activities.

**Designee:** an appointee; an individual designated for some task.



**Developed country:** country with significant industrialization, high GNP, high literacy rate, and strong economy.

**Developing country:** country that has low to moderate industrialization and low gross national product.

**Didactic approach:** an educational (instructional) methodology focusing mainly on a lecture delivery format, deductive in nature; the teacher as the source of knowledge.

**Dynamic equilibrium:** a tendency toward homeostasis; stability over time with periodic fluctuations.

**e.g.:** symbol for "for example".

**Ecology:** the scientific study of the interrelationships that exist between organisms and between organisms and their physical environment.

**Ecomanagement:** any physical action taken by an individual or a group aimed directly at maintaining or improving the existing ecosystem(s), e.g., reforestation, landscaping, installing bird boxes.

**Ecosystem:** an aggregate of plants and animals which are interdependent plus the abiotic variables with which they interact; typically thought of as self-contained in the sense that many of the essentials for life can be cycled and recycled within that system.

**Egocentric thought:** A tendency on the part of individuals to assume that all others see things as they see them.

**Emigration:** the movement of members of a population out of one locality into another; usually a permanent move.

**Empathy:** a feeling for; sympathetic identification with something, such as empathy for an endangered species.

**Empirical:** based on observation; founded on direct experience or experimentation; scientific.

**Empiricism:** the mode of thought which is typically scientific in nature, a philosophy focusing on the reality of observation and experience as the basis of truth; scientific method.

**"Empowerment":** as used in this document, a personal feeling of being in control of a situation, e.g., the individual becomes convinced that he/she is able to effect change with regard to a particular environmental issue.

**Energy transfer:** in ecology, the movement of energy from one life form to another in a food chain.

**Entropy:** a measure of the degree of disorder brought about by an increasing complexity within a dynamic system; a thermodynamic measure of energy unavailable for useful work in a system undergoing change.

**Environmental action skills:** see "Citizenship action skills".

**Environmental degradation:** Depletion or destruction of a potentially renewable resource such as soil, grassland, forest, or wildlife.

**Environmental education:** that aspect of education that develops individuals who are environmentally knowledgeable and, above all, skilled and dedicated to working, individually and collectively, toward achieving and or maintaining a dynamic equilibrium between the quality of life and the quality of the environment.

**Environmental impact assessment:** An evaluation of the extent to which certain activities will negatively impact/influence the environment.

**Environmental issue:** a problem with obvious environmental overtones surrounding which one can observe differing human beliefs and values.

**Environmental literacy:** that state in which an individual is environmentally knowledgeable and, above all, skilled and dedicated for working, individually and collectively, toward achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment. (Paraphrased from Harvey, 1977)

**Environmental sensitivity:** a set of affective characteristics which result in an individual viewing the environment from an empathetic perspective.

**Erosion:** the processes by which the materials of the earth's crust are transported from one location to another by forces such as gravity, wind, water, and glacial ice.

**Espouse:** to take up a cause; to take up as a supporter of a cause.

**Facilitator:** a person who makes something easy or less difficult.

**Family planning:** providing information, clinical services and contraceptives to help couples choose the number and spacing of children they want to have.

**Feasible:** possible; if something can be done it is feasible.

**Feedlot (Animal):** place where many animals are confined to be fattened for sale to meat processors.

**Fertilizer:** a chemical (natural or man-made) used to increase crop production.

**Food chain:** a linear pattern describing the flow of energy through an ecosystem; typically beginning with a food producing plant being eaten or partially eaten by a herbivore which is, in turn, consumed by a carnivore, etc.

**Food web:** a set of interrelated food chains within a given ecosystem.

**Formal educators:** those educators who typically teach within the constraints of the traditional school; classroom teachers.

**Groundwater:** Water that is stored naturally, underground in reservoirs called aquifers.

**Heat:** The sensation of warmth. A form of energy. Temperature differentials cause heat to flow from one body to another.

**Hierarchy:** an organization of things arranged one above the other according to a logical order, e.g., a hierarchy of goals.

**Homeostasis:** the tendency to maintain normal internal stability in an organism or an ecological system, such as a hardwood forest, by coordinated responses of the system's components, compensating for environmental changes.

**Humidity:** a measure of the amount of moisture in the air.

**Hydrosphere:** Those regions of the earth that contains its liquid water, frozen water, or the water vapor in the earth's atmosphere.

**i.e.:** symbol for "that is".

**Immigration:** the movement of a population or a portion of a population into a particular area: usually a permanent move.

**Impetus:** a driving force; incentive; stimulus.

**Infusion:** an injection of one thing into another; the process of infusion; as used here, injecting traditional course content with appropriate/logical environmental content, skills, and activities.

**Insolation:** the amount of light energy that an area receives from the sun.

**Irreconcilable:** not reconcilable: problems which cannot be resolved are considered to be irreconcilable.

**Issue investigation skills:** those skills which will permit the learner to successfully research an issue, resulting in appropriate conclusions, inferences, and recommendations.

**J-curve:** associated with the letter "J" which depicts the growth curve of an eruptive population or organisms, e.g., man.

**Learner objectives (also performance objectives):** those objectives prepared for the student to learn/accomplish: objectives which will be met through instruction, stated in performance (behavioral) terms.

**Legal action:** any legal/judiciary action taken by an individual and/or organization which is aimed at some aspect of environmental law enforcement - or, a legal restraint proceedings some environmental behavior perceived as undesirable, e.g., law suits, injunctions.

**Limiting factors:** in ecology, those variables which tend to put limits on the development of an ecosystem or on the activities of an organism; anything present in insufficient amounts so that an organism's survival and/or reproduction is restricted.

**Lithosphere:** that part of the earth's crust made up of solid material, as opposed to the "hydrosphere".

**Livestock farming:** The husbandry of certain domestic animals (e.g., cattle, hogs, chickens, sheep, goats) for personal use or for sale as meat.

**Methane:** A gas found naturally within earth (a "natural gas"); a gas produced during some forms of decomposition; CH<sub>4</sub>.

**Monobiotic agriculture:** growing only one crop in a relatively large area, e.g., a pine plantation, corn field, soybean field, rubber plantation.

**Natality:** refers to live births or birth rate.

**Natural Gas:** Underground deposits of gases, often composed mostly of methane.

**Natural selection:** the survival of a genetic form over time as a result of a particular adaptation favoring that organism.

**Niche:** an organisms' role in a community; not to be confused with where an organism lives.

**Nonformal educator:** the educator who provides instruction in settings beyond the traditional confines of a formal classroom, e.g., a teacher in an environmental center.

**Opinionnaire:** a survey instrument designed to assess the opinions of a particular population of human beings on a specific topic.

**"Ownership":** as used in this document, a feeling of empathy or personal association with a particular issue; to feel an intense interest in a particular environmental issue with an associated desire to investigate and help remediate it.

**Ozone layer:** layer of gas in the stratosphere that protects life on earth by filtering out harmful ultraviolet rays.

**Parameter:** a limit; boundary.

**People overpopulation:** situation where there are more people in a region than the available supplies of food or water can support.

**Performance objective:** See "learner objective".

**Persuasion:** an effort, verbally, to motivate human beings to take positive environmental action as a function of modified values, e.g., argumentation, debate, speech making, letter writing.

**Pervasive:** diffused throughout; to permeate.

**Phenomena:** events; happenings that may be observed. Singular: phenomenon.

**"Player" (in an issue):** someone involved in an issue, a person having definite beliefs (and a particular position on the issue) and certain supporting values.

**Point sources (of pollution):** a specific and definable point which serves as a source of pollution, e.g., smoke stack, sewage treatment plant.

**Political Action:** an effort aimed at persuading an electorate, a legislator (or legislature), or executive governmental agency to conform to the values held by the person or persons taking that action, e.g., lobbying, voting, supporting candidates.

**Population dynamics:** those interactions which can be observed taking place within a particular species population; population dynamics often refers to those variables which influence the population size of an organism over time in a given ecosystem/biome.

**Portray:** to make a picture of image of; to depict in words; to describe vividly.

**Prerequisite:** required before; necessary as a preliminary to a proposed act.

**Primary source of information:** a source of information which represents an original source of knowledge, e.g., information from the people actually involved in an environmental issue as opposed to information from an article written about those people.

**Proponent:** one who makes a proposal; an advocate.

**Questionnaire:** a survey instrument designed to gain information held on a particular topic by a certain population of human beings, e.g., college students, the general public, wildlife biologists.

**Radioactivity:** the property of being radioactive; the radiation given off as a consequence of radioactive decay, e.g., the radioactive decay of plutonium.

**Rationale:** an explanation; an underlying reason.

**Recycle:** to use again, in some productive manner, materials which are often considered as solid wastes by segments of a human population, e.g., aluminum, paper products, glass, plastics.

**Remediate:** to remedy, to restore, cure.

**Role playing:** to assume the role of a particular individual in an educational simulation activity, e.g., a student "plays the role" of a conservationist in a simulation designed to explore all sides of a particular environmental issue.

**Scenario:** the outline or synopsis, step-by-step, of a plot or an event; contains all the details of a plot or an event.

**Science processes:** those critical thinking skills a scientist uses to collect data or solve problems, e.g., hypothesizing, experimenting, inferring.

**Scientific literacy:** the state of being literate in science; an awareness of and ability to use science, its content, processes, and applications.

**Secondary source of information:** a source of information at least one time removed from the primary/original source, e.g., reading an article written about an issue as opposed to investigating that issue on a first-hand basis.

**Simulation:** something that assumes the appearance of reality without being real; the act of simulating; feigning.

**Solar energy:** Radiant energy from the sun; also other forms of energy which are byproducts of the interaction between solar energy and the earth, e.g., wind.

**Solicit:** to seek to acquire; to plead for; to request.

**Solid waste:** materials thrown away and in need of disposal, not usually associated with wastes such as radioactive or toxic/chemical materials; often wastes with materials which could be recycled.

**Spatial:** pertaining to space.

**Species population:** an interacting group of organisms belonging to the same species; not to be confused with the species as a whole.

**Stance:** a position: someone's posture on something.

**Strip mining:** the removal of the surface layers of soil and rock so that important mineral deposits can be removed for use by man.

**Subsidence:** a sinking of the earth's surface due to some underground excavation, e.g., the removal of ground water or shaft mining.

**Substrate:** a foundation; a term often used in agriculture and ecology to refer to subsoil or the rock layers underlying subsoil.

**Subsumes:** include under: to take up: specifics are subsumed within the general, or individuals are subsumed within populations.

**Succession:** the progression of plant communities from one to another in a given locality: often begins with a pioneer community progressing through a series of plant communities toward a climax plant community.

**Survey:** a mechanism for gathering information about something, e.g., a survey of abandoned vehicles in Jackson County, Illinois, a survey of public opinions concerning the acid rain issue: to take a broad or comprehensive view of something.

**Synergism:** an interaction which yields a greater effect than the sum of the two effects where the interaction does not take place: combined action, such as the synergistic effect of two drugs being greater than the effect of either taken individually; in an environmental sense, often the combined action of substances in the environment.

**Syntax:** orderly arrangement: to put in order, a sequence.

**Synthesis:** a combination of parts as to form a whole; building up something from its elements: combination of thoughts into a whole; the opposite of "analysis".

**Topography:** the undulations of the earth's surface: the configuration or relief of a surface.

**Value (i.e., a value):** an established ideal; a way of acting; the perceived worth of something, e.g., the perceived worth of wildlife.

**Value position:** the value category underlying a particular belief statement or verbalized position on an environmental issue, e.g., a person who wants to preserve a marsh because there is good duck hunting there is reflecting a recreational value position.

**Values clarification:** the process an individual goes through as he/she inspects the bases for a value perspective, e.g., the process and individual would go through as he/she seriously inspects a personally and particularly strong economic value.

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