

GLOBAL USE OF RISK ANALYSIS FOR SUSTAINABLE DEVELOPMENT

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SUMMARY

Sustainable development is defined as: "integrated strategies that would halt and reverse the negative impact of human behavior on physical environment and allow for livable conditions for future generations on Earth "(UNCED 1992). The concept of sustainable development resulted in the Agenda 21, developed at the Earth Summit in Rio de Janeiro, 1992, which presents a blueprint for development of humanity in the 21st century agreed upon by a majority of countries on Earth. Majority of human societies (countries) are not sustainable, since they are highly dependent on fossil fuels and non-renewable resources, which are being rapidly depleted.

Environmentalists often dispute the causes of global environmental degradation. Some blame it on population growth [P] in developing countries (SOUTH), some on unbridled consumption [C] in developed countries (NORTH) and some on the polluting technology [T] and low energy efficiency (EAST and SOUTH) and/or large consumption of energy (NORTH) [E]. In reality, all of the four factors are important contributors, and modified Ehrlich' equation can be written as:

Environmental Impact (EI)= P x C x T x E
(this is qualitative and not an exact mathematical expression)

P= population

C= consumption

T= technology

E= energy consumption (E)

The importance of each factor in any locality varies. Western Europe and North America contribute mostly to the consumption and energy use [C and E], while in developing countries, the major factors are population (P) and polluting technology (T) (in those countries that are attempting to industrialize). Also, often, the energy efficiency is very poor (China and former USSR), even though useful energy consumption per person may be small. Countries of former USSR and Eastern Europe have stable and limited populations, and consumption is also low. However, their outdated technology and poor energy efficiency (T and E) are major contributors to tremendous environmental degradation of Eastern Europe uncovered after the fall of communism.

In order to deal with the environmental impacts of human activities and of development, one needs first to evaluate the problems. Risk analysis can help evaluate the problems resulting from improper industrial management, transport and energy management,

consider the proposed solutions and establish better management strategies that would promote sustainable development. Decision and policy makers (businesses, governments) and the "doers" (engineers, architects, city planners etc.) could perform risk analysis before they make investments and execute projects with a potentially high environmental impact. Comparing various options of risk management would result in most reasonable solutions. In addition, properly performed and documented risk analysis may uncover hidden agendas of various interest groups and thus promote democratization within a frame of sustainable development. It is important that the decisions about such policies or development are made at local or national level where people will benefit or be harmed by such decisions.

KEY WORDS: sustainable development, Agenda 21, energy, pollution, environmental impact, agriculture, efficiency, nutrition

1. INTRODUCTION

Governments and the societies around the world are on the crossroads for environmental decision making, which will determine the futures of next few generations, and possibly even the survival of humanity. They can proceed in an "as usual style" trying to get investments without determining the long-term environmental and economic impact of building new industries, transport, electric power plants, agriculture etc., or they could learn from the mistakes and positive experiences of the western democracies and the local cultures in their environmental management. Better business through better environmental management is the new paradigm for 21st century, which enlightened governments and businesses are starting to understand.

Number ONE environmental problem in the Western world is compartmentalization (Molak, 1990). Compartmentalization along the lines of scientific disciplines, and compartmentalization along the environmental media contributes to piecemeal solutions of environmental problems that often create bigger problems than those they are attempting to solve. Over the years, various disciplines have dealt with environmental problems from a very narrow scope. A chemical engineer would design a plant without worrying what to do with waste or how the emissions from the plant would affect the neighborhood. That problem was left for the environmental engineer, toxicologist or lawyer, years after the plant started operation. Toxicologists are studying mechanisms of action for various chemicals with little awareness of which chemicals are most likely to cause problems. Lawyers are demanding clear "yes" or "no" answers, when scientific evidence can suggest only possibilities, and the answer is "maybe". To solve the problem of compartmentalization, "cultural change" is necessary both in the government and the society at large. An interdisciplinary scientific activity such as risk analysis may become a part of this cultural change.

When dealing with environmental problems, such as global warming, acid rain, ozone hole, chemical contamination, resource depletion, deforestation, agricultural degradation etc., we are attempting to obtain a complete picture using all available data to perform risk analysis or in some cases cost/benefit analysis. For example, a large

interdisciplinary study on realistic mitigation options for global warming evaluated costs of various measures that could be undertaken in the USA to decrease amounts of greenhouse gases (CO₂, CH₄, NO₂, CFCs and others (Rubin et al. 1992). They evaluated electricity efficiency, industrial energy use, transport efficiency, and power plants. The authors calculated that with the current technology one could reduce the CO₂ equivalent production in the USA from 7900 Mt/year to less than 6000 Mt/year, with just improving efficiency. The cost of such improvements would be actual savings, ranging anywhere from savings of \$62/ton conserved to spending 1\$/ton conserved (in case of increase of the capacity of nuclear power plants). Generally, the largest saving could be achieved in residential and commercial energy use by improvements in efficiency. Measures to improve efficiency range from designing new household appliances such as refrigerators, furnaces and efficient light bulbs to simple solutions, such as planting trees around houses and having white roofs to deflect sun in summer, or use of sun to heat water or prepare food. Additional reduction in CO₂ emissions of 3600 Mt/year could be achieved by changes in transportation habits, developing new electric supply technology such as solar, wind, biomass, hydroelectric and others, decrease in ruminant animals and nitrogen fertilizers, and reforestation. Some of these measures may require initial investment that will take longer to recover. Therefore, small alterations in the way we conduct our daily lives could have doubly beneficial effect; decrease in fossil fuel consumption, decrease in greenhouse gases production and saving in energy costs. A small investment would further substantially reduce our dependence on fossil fuels and decrease USA energy consumption by 75% without decrease in quality of life. On the contrary, the quality of life would improve, because of decrease in pollutant emissions, and increase in exercise. This would be achieved without radical changes in transportation policies. With changes in transportation policy, where personal vehicles would be replaced by efficient public transportation systems, bicycles and increased walking, the energy consumption could be further reduced. This study clearly demonstrates that energy efficiency is the most economic way of reducing greenhouse gas emissions and that the only barrier in their implementation are institutional barriers and unwillingness to change (Rubin et al. 1992). A side benefit of decreased energy consumption would be also a decrease in acid rain, which is the result of use of coal in electric power plants. Although this study does not specifically analysis risks of high energy consumption (which can be expressed in global warming and/or acid rain), it indicates that risk reduction would be a side benefit of energy management.

In former communist and developing countries, which are in the stage of forming new institutions, the implementation of energy efficiency in all types of activities is essential. During rebuilding or developing new infrastructure one can implement all the findings on energy efficiency, rather than trying to imitate the western way of high consumption. It maybe more prudent to increase energy efficiency than develop fast exploitation of natural resources in Russia and other East European countries and further contribute to CO₂ and other greenhouse gasses emissions. Risk analysis of various energy options in Eastern Europe can point towards most optimal developments of energy resources and their most efficient use. Based on Western experiences with transport problems, those countries maybe able to avoid becoming dependent on cars, and thus contribute to

sustainability.

In an interesting way, it appears that humanity, in order to survive, has to adopt the problem-solving methods used by some native Americans: A "medicinal circle approach", in which various wise tribal people contribute to finding a solution, and "considering the seventh generation" when making an important tribal decision. An interdisciplinary vs. simplistic approach, and long-term vs. short term reasoning seems to be the only way out of the environmental catastrophe toward the humanity seems to be heading. Risk analysis can provide a framework for this type of reasoning and contribute to improvement of quality of life in communities around the world.

2. ENERGY AND POLLUTION

One of the most critical areas of human activities is the use of energy, both for heating, cooling, performance of mechanical work and for transport (Molak V., 1990). Risk analysis can help promote a rational decision making in energy production and use policy most beneficial for the environmental quality (Molak B, 1990). For example, in order to have less sulfur dioxide pollution in Zagreb (Croatia), a decision was made to use oil (with low sulfur content) in the thermal plant. The individual apartment buildings are still heated by using high sulfur coal. However, a risk analysis of the problem reveals that the bulk of pollution comes from individual houses, and the best cleanup strategy would be to continue burning a high-sulfur coal in the thermal plant with installing a scrubber for sulfur, but use oil in the residential buildings. In that way, the cost of the scrubber would soon be made up with savings from fuel (coal is cheaper than oil). Additionally, the use of more expensive fuel, oil, in residential buildings would encourage energy efficiency, because consumers would have an incentive to conserve energy. Similarly, locally based risk analysis could be used to determine the best energy production and use management. Energy production and use can be evaluated for its impact on the environment using risk analysis techniques, and the choices should be made for the cleanest and most efficient energy production for a particular location (be it coal powered, solar, hydroelectric, wind, geothermal, nuclear or other). Risk analysis could help make the most optimal choice, by uncovering all the available data and putting them in a proper framework. Comparative risk analysis studies in the past pointed out the relative advantages of nuclear energy, based on number of deaths associated with unit energy production. However, Chernobyl accident had altered those numbers, since thousands of deaths are attributed to radiation exposures in the aftermath of the accident.

The world statistics on uses of coal, oil, gas, hydroelectric, nuclear, wind and solar energy are indicating some encouraging trends (Vital Signs, 1994). Since 1990, oil production has leveled off and even decreased, as did coal production. Nuclear energy is becoming increasingly unpopular, and the electricity production declining due to the age of many reactors. Natural gas production has increased as did the use of wind energy and solar energy. This trends could be accelerated by proper use of risk analysis in evaluating available energy options in a given area.

Energy efficiency can be enhanced on a national level by developing most efficient household appliances. Instead of building light fixtures or other electrical appliances factories in an old way, technology of high efficiency and long duration products should be purchased from the best vendors. In addition, architects and builders could incorporate energy efficient design in mass production of both individual and apartment buildings. Reliance on local wisdom and materials at the site may be more prudent than attempting to imitate large, energy demanding buildings development that occurred in the last 50 years in the US and other developed countries. World lending institution, which are responsible for many developmental projects, should incorporate long-term environmental and human health risk analysis in all proposed projects. Many of such projects in the past would not pass the test of risk analysis, since the long-term consequences of their implementation would be uncovered. For example, building large dams, such as Aswan or dams in Brazil, resulted in tremendous negative environmental impacts while benefiting few people and only for a short time (Molak, 1990).

Since the fall of communism, new opportunities toward sustainable development have presented themselves to the World bank and other international lending institutions and private investors. Economic risk analysis may use methods of green accounting in analysis of trends, rather than GNP, which is generally a crude and often false measure of well-being of population (Gore, 1994, Vital Signs, 1994). Countries in tropical and subtropical climates maybe able to directly capture the sun energy rather than depend on oil. Suggestions made in Rubin et al. (1992) could be implemented in each new energy initiative. Using risk analysis may provide the necessary rationale for a change (or maintenance of status quo). However, to derive all the necessary data to perform risk analysis, a free access to information must exist. Only in transparent democratic societies, with checks and balances, can possible hidden agendas of national and local decision makers be uncovered and public empowered to take the course of action that would benefit society as a whole. Agenda 21 principles of sustainability could be incorporated into free market mechanisms by creating policies that would encourage energy efficiency and renewable energy uses (UNCED 1992).

3. TRANSPORTATION

"Monsters are prowling our land. They are devouring irreplaceable resources at increasing rates. Their wastes are fouling our air and may even be changing the climate of our planet. And they may doom our children and grandchildren to a world of unimaginable problems" (Union of Concerned Scientists letter to members, 1992). The monsters are cars, which are using almost 80% of oil in the USA, and in most cities account for over 60% of total air pollution (the rest comes for power plants and chemicals production and use)! Unfortunately, ~60 years ago in the USA, many efficient public transport systems were destroyed by car makers and oil companies who needed more consumers for their products. Tram lines were paved over, and tram cars destroyed or retired into museums. Also, USA passenger railroad traffic was practically eliminated. Europe has fortunately maintained its public transportation systems, its trains and compactness of its cities. Eastern European countries could thus learn from the USA and European experience, either to maintain or develop an efficient public transportation

system (including trains), and discourage use of personal vehicles, or follow the fate of many USA cities where one cannot function without a car. Risk analysis can be used to point out the costs and environmental consequences of current road building trends in USA and recently in Eastern Europe and developing countries, where valuable agricultural land is being lost in order to build roads, parking spaces and shopping malls.

Even if a non-fossil fuel, clean car is invented, it would still contribute to traffic congestion in the cities. The only long term solution to transport problems is public transport, and increased use of walking and bicycles. Bicycles are the most economic way of transport: per mile traveled a single passenger expands 50 times less CO₂ than when using a car (State of the World 1991). Therefore, with developing of new streets, or repaving old streets, bicycle and pedestrian lanes should be added, especially in flat areas. Gradually, a whole bicycle and pedestrian infrastructure could be built, during routine repaving of roads or during new developments, without large expenditures. Creating more livable communities, where need for commuting to work is decreased either by making communities more compact or use of computers in working from home is another way of dealing with transport problems. World statistics (Vital Signs, 1994) point out some encouraging signs of change around the world. The car production has declined to 34 million (in 1993), while bicycle production is on rise (108 million in 1993). In developing countries most people cannot afford cars, while in developed countries the environmental awareness of citizens is gradually leading to policies away from unbridled use of cars. In Japan and Denmark, combining bicycle and train commuting to work is very popular (in Japan, 3 million commuters chose this option and in Denmark 25-30% of all train commuters come to the train by bicycle). Risk analysis could encourage the shift toward bicycles by illustrating hidden costs of car use, such as costs of building and maintaining roads, hidden costs of oil, costs of accidents on the roads (compared to those of public transport of bicycling) etc. For example, world death toll of car accidents is ~500,000 people/year, and in the USA alone more than 40,000 people die each year (Vital Signs, 1994). Risk analysis indicates that with mandatory seat belts and lower speed limits the number of deaths in the USA decreased (from 55,000 in 1970) even though the number of miles driven increased. Thus, any policy that deals with transport could be evaluated in advance. For example, simple risk analysis indicates that seat belt wearing and speed limits should not be abolished, unless one is prepared to deal with an increase of car accidents deaths and injuries. If one also takes into account the high costs of injuries, one may make a compelling case for decreasing car use and finding alternate ways of moving people around, or decreasing the necessity for commuting, by building more compact and sustainable communities.

Based on analyses of CO₂ production and air pollution, one should consciously and energetically strive to remove "THE MONSTER" (cars) from the roads to the greatest extent possible, and educate the public (which now accept cars as a status symbol), that cars lead to an overall degradation of the environment and dependency on foreign oil (Lowe, 1994). Public transport by most efficient vehicles, walking, and bicycle use should be encouraged by developing national and local policies that would liberate free market mechanisms in service of sustainability and building livable communities. At this

point, most of the policies encourage the use of cars and free market mechanisms are tampered with by the policies in which municipalities and states bear the costs of new roads and infrastructure development and maintenance, while road builders and housing developers are the major recipients of the benefits. Our dependence on foreign oil increases real cost of oil (since war machinery is necessary to maintain the access to oil fields, as was demonstrated in the Desert Storm), although this cost is not reflected in prices, as it should in a free market. In addition, costs from air pollution attributed to cars were estimated to \$5-85 billion/year (Cannon, 1990). Risk analysis can point out the hidden costs of car dependence and thus encourage municipalities to develop alternate transport means. Experts in risk communication could devise best "persuasion scheme" to accomplish this goal. Since advertising is a tool companies use to increase their market share, municipalities could use it for promoting behaviors useful for sustainable development. Success of such approach was demonstrated in Cincinnati in summer of 1995, when ozone in the city air compelled the city officials to request from citizens to ride buses in order to save the city of consequences of ozone-non-attainment (personal communication). Within several days the bus ridership was increased by 15-20%. Decreases in price of tickets also helped. Thus, equitable free market mechanisms could be used as a driving force behind the sustainability principle implementation in transport (Colby, 1990).

Cars are one of the major causes of an environmental crisis for the United States of America, resulting in dependence on foreign oil; air pollution in the cities etc. Inefficient and short-sighted urban planning results in traffic jams and long distance commuting to the suburbs, which are inaccessible without cars. Additionally, large areas of natural habitats are lost to suburban sprawl, roads, parking spaces and shopping malls, and thus lead to a disappearance of species. Lack of the opportunity to walk and bicycle on the streets leads to a degeneration of American health due to non-use of muscle, in addition to health effects of polluted air.

4. INDUSTRIAL POLLUTION

Traditionally, industrial pollution has been used as an indicator of environmental degradation. The amount of toxic waste generated in USA is very large. According to the Community Right to Know data, companies release 100 pounds of toxic chemicals per each citizen every year (Molak 1989). This consists of the chemicals releases into the air, water and disposed as solid hazardous waste. However based on national Resource Conservation and Recovery Act (RCRA), the real amount of toxic waste is probably 2000 lbs (950 kg) each year, since Toxic Release Inventories report only 5-10% of total releases, because of various exclusions in the law. This pollution affects the quality of air in the vicinity of industrial facilities, surface and sometimes drinking water, and communities living near production plants and hazardous waste sites (Molak 1989). An effort is made to decrease industrial pollution in the United States. While in the past, an emphasis was on pollution controls (filters and scrubbers at the end of the pipe, or water filtering before releasing), current wisdom is to reduce pollution at the source (US EPA 1992).

Industrial production facilities can be built with closed circles of material flow, with zero waste, and just-in-time delivery (see Chapter II.3). Comparative risk assessments of various products could be performed following "the cradle-to-grave" principle, and only those products should be chosen which have minimal impact on the environment and fit into geobiochemical cycles of Earth. The products could be designed for real needs, rather than artificially created needs promoted by inaccurate and often false advertising (Fromm 1981). Such production would also a decrease need for consumption, which frequently serves as a substitute for lack of fulfillment of community and other social needs (Rifkin 1991). While tampering with market mechanisms is dangerous, the realization that those mechanisms depend on policies is necessary in order to promote policies that develop more equitable and sustainable society (Hayek, 1976). Only environmental laws established in last 20 years have compelled free markets to encourage responsible corporate citizenship. Thus, dissolution of those environmental laws may lead us back to rivers bursting in flames (see Chapter III.5). Economic risk analysis can indicate that pollution prevention pays, and thus it also makes good business sense (Molak, 1991). While investments into pollution prevention could in some cases be immediately recovered by savings in raw materials, longer-term policies are necessary for pollution prevention encouragement on a wider scale.

A possibility of acute toxic releases of toxic chemicals used in production of various products should be evaluated and every step taken to minimize the impact on the neighboring population and workers. A type of risk analysis called "hazard analysis" according to the Community Right to Know law could also help prevent accidents as it is doing in the USA (US EPA, 1979).

4.1. POLLUTION PREVENTION PAYS

The law that made pollution prevention possible is the Community Right-to-Know law or SARA, Title III. Spurred by the 1984 accidental release of the toxic chemical, methyl isocyanate, in Bhopal, India, which killed over 3,500 people, SARA, TITLE III is intended to increase the protection of the American public from the adverse effects of hazardous chemicals used, produced, and released from factories and transported via highways, railroads and waterways. In 1988, for the first time in history, it became known to American public and officials how much toxic chemicals get thrown into the air, soil and water of America. This awareness encouraged both private citizens and EPA officials to require from industry to decrease the release of toxics. Reacting to the public outcry and realizing that waste reduction will also save money on raw chemicals, industry in America is evaluating its industrial processes, and deriving most efficient engineering solutions for reduction of waste at the source. Since pollution can be viewed as resources distributed in the wrong places, pollution prevention equates to a decrease of resource waste, and thus, saving money. Numerous examples showed that pollution prevention leads to decreased production costs and increased profits (Molak, 1990, 1991). Large companies in USA, such as 3M, Dow Chemical, Monsanto, P&G, and others, all have a pollution prevention programs that have already significantly reduced those companies toxic wastes and releases. Further reduction is encouraged by various US Environmental Protection Agency's programs.

5. URBAN PLANNING

The main cause of ecological impact and species destruction is destruction of natural habitats caused by development. It is essential that urban planning is carefully used before developing or enlarging a city. Current policies both on local and federal level encourage urban sprawl, since larger profits are made by building on agricultural land than on existing city grids, a result of unwise policies where the municipalities bear the costs of transport to new developments. Thus, free market is only apparently free; in reality, current policies and subsidies promote artificial incentives toward non-sustainable development. The size of a unit city can be small enough to encourage public transport, bicycle lanes, walking, car pooling etc. Free market mechanisms could be devised to limit size of the community by a green belt around the city that would prevent developers to build new remote houses. The best example of such a city is Portland, Oregon (Lowe, 1992). Planning of new building developments has been coordinated with increases of public transport activities, and thus although Portland experienced doubling of its work force Downtown, the number of private cars that come to Downtown each day stayed the same. This is mostly attributed to improvement in city planning and public transportation. Bicycles could become vehicles of the future for 1-15 km trips, which are frequently the extent of commuting mileage of suburban dwellers. In addition, urban renewal of inner cities may decrease need for new suburb development, which is harmful in a long-run. Perhaps incentive for redevelopment of inner cities, rather than new suburbs development could be designed by the cities. In addition to planning location of new housing units, urban planning could be used to promote energy efficient materials and experimentation with newest energy efficient houses, rather than old-type architecture of energetically demanding high rises and houses. Local developmental policies can incorporate sustainable development concepts into each step of urban planning and provide incentives for sustainability, using various market mechanisms, rather than rigid uniform rules.

In order to minimize commuting from home to work, urban planning should be developed that takes into account the waste of time and energy in commuting. The factories, offices and other work places can be located in most accessible areas for its employees. Very sophisticated models in urban planning already exist in the USA and Western Europe and are tried in several cities in the USA (for example Portland, Oregon). World Watch institute's report on STATE FOR THE WORLD 1992, describe some of the progress made in urban planning and other activities that can lead to sustainable society.

6. AGRICULTURE

There is a movement among health conscious consumers in USA to buy "organically" grown fruits and vegetables, which encouraged the development of many "organic" farms (Robbins, 1990). These farms do not use pesticide, herbicides and chemical fertilizers, but use organic fertilizers (manure), crop variation and mechanical weeding. The yield on those farms is somewhat smaller than at the conventional farms, but this is made up by

saving on chemicals (which are becoming more expensive, since the insects are becoming resistant to pesticides and larger amounts of pesticides are needed (Vital Signs, 1994). Risk analysis in this case may indicate potential for worker's contamination and food contamination and make stronger case for use of organic agriculture. Consumers are willing to pay more for certified organic products because they do not want to ingest pesticides and herbicides, and because of higher nutritional value (Robbins, 1990). Also, no till agriculture is being implemented, which decreases soil loss, one of the major problems in the world (State of the World 1990).

A gradual return to sustainable agriculture can be implemented, with slow decrease in use of pesticides and herbicides. More health oriented diets could be developed, based on whole grains, vegetables and fruits, with decrease in meat consumption, which takes 10 times more resources to produce than vegetables for grains (with the same nutritional value) (Robbins, 1994). For every meat eater, 3-4 vegetarians could be fed, which would practically eliminate any food shortages currently existing (provided that the food is grown in the right places). One of the problems in current agriculture is that developing countries have become dependent for their feeding on western nations, partially because of high population growth but also because of developmental policies encouraged by lending institutions promoting cash crops rather than sustainable food supply. Such cash crops are energy intensive and lead to all the pitfalls of chemically based agriculture and soil loss. Again, a comprehensive risk analysis, both for human health effects and for environmental impacts can provide a framework for most sensible policies to encourage sustainable development.

Numerous epidemiological studies and studies in animals have demonstrated a strong correlation of nutrition and various (especially degenerative) diseases (Campbell, 1992; O'Connor 1987). Generally, consumption of animal-derived foods (meat and dairy products) is associated with an increased incidence of degenerative diseases, while consumption of whole grains and vegetables decreases the likelihood of those diseases (Campbell, 1992; Barnard, 1993). For example, there is a strong correlation between nutrition and cancer (O'Connor, 1987). Also, recent studies in heart-disease treatments have indicated clear benefits of eating non-animal foods (grains, vegetables, beans etc.) (Ornish 1993). Caloric restriction diets in experimental animals have been demonstrated to prolong the longevity and decrease the incidence of degenerative diseases, such as heart disease and cancer. Prompted by this research, American recommendation for proper nutrition have changed: We don't teach our children "4 groups of food" any more, but nutritional pyramid, where grains and vegetables are on the bottom (most recommended consumption) and meat and milk products at the top (no or small consumption recommended).

Going one step further, one can make a link between eating from the high end of the food-chain (animals and animal products) and environmental degradation. Eating meat and milk products is energetically wasteful: Production of 1 kg of beef takes 10 kg of grain, in addition to destroyed forests to provide pastures for cattle grazing, and ~38,000 liters of water necessary to produce each kg of beef (Robbins, 1990). Also, one should

consider environmental impact of methane production from ruminants, water depletion associated with beef and other meat production; water pollution because of nitrates and phosphates and cow«waste, air pollution around the feedlots etc.

We are an "instant culture", where an abundance of material goods produced an impatience in achieving goals, and a desire for instant gratification (Fromm 1981). Our consumption (both industrial, energy, and food) in the USA is one of the major contributors to the overall negative environmental impact (Postel, 1994). Our food consumption, including a large consumption of meat is one of the major contributors to agricultural degradation, since the production of meat requires large amounts of grain production (Robbins, 1990). Long-term risk analysis of our eating habits can help point a way to decrease the negative impact they have on our health and the environment.

7. POPULATION EXPLOSION

Finally, no responsible environmental policy can leave out of consideration the impact of population growth on the overall quality of life. Although European population is approaching 0-growth, one of the major problems in developing countries (Africa and Latin America) is rapid population growth that is exceeding Earth capacity (Ornstein and Ehrlich, 1990). All the advance in environmental protection (clean air, water and soil, easier commuting, energy efficiency etc.), will be foregone if the population keeps growing. The finality of Earth resources is a given, and therefore Earth systems can support only a limited number of people. Therefore, a prudent policy would be to encourage limits in a number of children per family, rather than encouraging large families. Although this policy may appear as a part of overall social policies, it is equally pertinent to pollution prevention and environmental protection in general. A goal of any enlightened community should be an overall 0-population growth, and sustainable development that will enable high quality of life to all its citizens. In a democratic society, people would decide for themselves the meaning of the term "quality of life". As Thomas Jefferson stated: "People are inherently capable of making proper decisions when properly informed."

Recent trends in armed conflicts around the world (numerous local and regional conflicts), shows increases in risks of death and injury from violence by other human beings. In addition, destruction of infrastructures and environmental risks are also increasing. Although arms trade is rapidly decreasing (in large due to disintegration of USSR, one of the biggest arms traders before the fall of communism)(Vital Signs, 1994), currently, the world is filled with weapons, which often become sources of intimidation and increased risk of death. Risk analysis points out that in war situations all other risks combined pale in comparison with the risks caused by a deliberate destruction of the armed forces. While a cynic may argue that war is one of the ways of keeping a lid on population explosion, it is incompatible with the foundations of democratic and humanistic culture and international foundations of human rights (UNCED, 1992).

8. CONCLUSION

Humanity and the modern western culture as we know it may be in decline (From 1991; Ornstein and Ehrlich 1990). The modern society is not sustainable, because of high consumption of non-renewable resources such as fossil fuels and minerals, and creation of waste which is very recalcitrant to enter geobiochemical cycles of Earth. The Earth Summit in Rio de Janeiro (June 1992) has clearly expressed this concern. As Mr. Vaclav Havel, the first President of democratic Czechoslovakia, noticed in his first speech to American Congress in 1991: "Without a global revolution in the sphere of human consciousness, nothing will change for better in the sphere of our being as humans, and the catastrophe toward the world is headed - be it ecological, demographic, social or general breakdown of civilization - will be unavoidable." Humanity is out of step with nature (Lovelock, 1969) and Gaia may respond following Le Chatelier principle, by eliminating the species causing disturbances in the great scheme of things on Earth. Risk analysis may contribute to a development of this "global consciousness", and avoidance of a gloomy prophecy.

On a smaller scale, each country can follow sustainability principle, as expressed in the Bruntland's report in 1989 or at the Earth Summit in 1992. Sustainability principle could be implemented at the local level even more diligently, thus promoting self-sufficiency. Developing countries and former communist countries (countries in transition) are in an ideal position to follow this principle, just as Germany and Japan were in a position to modernize their industrial production after their industry and infrastructure were destroyed in the World War II. Marshall plan did wonders for both Germany and Japan leading to their economic well-being and efficiency in production. There is an opportunity in former communist countries and developing countries to build a new infrastructure and an industrial system which will incorporate efficiency and clean technologies, while keeping material consumption relatively low.

Experience developed in the USA and Western Europe that could help in establishing sustainable societies, and new clean and efficient technologies are already in existence. This experience and technologies could be adjusted to local conditions by local scientists and engineers, who know their particular country. In addition, local wisdom of sustainable living and adjusting to natural environments could be revived and applied. For example, rather than rebuilding houses, hospitals, kindergartens and other buildings in an energy wasting way, one should apply a combination of the old wisdom and the most modern energy research, and build houses (components of which are already either commercially available or available locally), which use much less energy used by conventional buildings. Current building industry could be given the incentives to incorporate new technologies to provide durable housing and energy efficiency in its housing units. At the same time, one should develop local capacities for building and use of local knowledge and self-sufficiency, rather than making decisions far away from the localities where people have to live with those decisions.

In addition, technological solutions are only a part of achieving sustainability. The concept of development should not be tied to the growth in GNP, and a more complex measure of development should reflect non-material, less tangible parameters that

increase the quality of life for majority of people (From 1981).

Risk analysis, in spite of its limitations, could be used on the regional and local level to evaluate alternatives in development and/or environmental management. It can indicate trends and patterns of environmental risks which could serve to establish most suitable environmental risk management, taking into account all the available knowledge.

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