

# **TRANSITION TO SUSTAINABILITY IN THE DEVELOPING COUNTRIES: THE ROLE OF SCIENCE**

**Carlos B. Aguirre**

*National Academy of Sciences of Bolivia, La Paz, Bolivia*

**Keywords :** developing countries, transition, sustainability, science policy

## **Contents**

1. Introduction: The New World, Present and Future Scenarios
  2. Sustainable Development
  3. A scenario of Transition to Sustainability
  4. Innovation in a Scenario of Transition to Sustainability: Challenges and Opportunities
    - 4.1 The Context
    - 4.2 Innovation in a Scenario of Transition to Sustainability
    - 4.3 Challenges
    - 4.4 Opportunities
    - 4.5 The National Innovation Systems in Developing Countries: An Overview
  5. The Role of Science in a Scenario of Transition to Sustainability in Developing Countries
  6. Science Policy for a Transition to Sustainability in Developing Countries
    - 6.1 Science Policy or Research Policy: Why a Policy at All?
    - 6.2 The Role of the State
    - 6.3 Main Science Policy Issues
      - 6.3.1 Policy Objectives
      - 6.3.2 Research Projects
      - 6.3.3 Independence of Research
      - 6.3.4 Image of Science
      - 6.3.5 Human Resources for Science
      - 6.3.6 Centers of Excellence
      - 6.3.7 Internationalization of Science
      - 6.3.8 Institutional Structure
      - 6.3.9 Management of Science
      - 6.3.10 Investing in Science
  7. Conclusion
- Acknowledgments  
Glossary  
Bibliography  
Biographical Sketches

## **Summary**

Developing countries need not only to provide quick responses to the increasing social and economic demands of their societies and improve their participation in the world dynamics, but also create at the same time, conditions for a long term sustained development. For these countries, a response to such a challenge is difficult for several

reasons, one of them, because they lack sufficient capacities to generate and use scientific and technological knowledge.

Considering its complexity, a transition to sustainability requires the definition and adoption of a large set of interrelated policies and strategies based on a systemic approach. Here, a simple scenario is described in which sustainable development is considered as composed of five dimensions and their linkages: economic, social, cultural, preservation and adequate use of the environment, and governance. Science plays a key role in understanding and providing solutions to problems in each of these dimensions.

Because science makes part of a non-linear development process, science (or research) policy by itself, does not constitute an appropriate response to the complex challenge of transition to sustainability that the developing countries must face. Such policy must be integrated into an innovation policy. Further, because science policy is principally a social contract, it is in effect an element of the new scenario. It is in this context, that the role which science plays in a scenario of transition to sustainability in the developing countries is discussed, and a set of policy objectives suggested.

While recognizing its importance, the epistemological limit of science is also recognized. In spite of such a limit, it should be borne in mind that no country that has ever developed has done it without conducting an effort in science. Today's developing countries will not be the exception in the new millennium.

## **1. Introduction: The New World, Present and Future Scenarios**

World interdependence and globalization are fundamental forces shaping contemporary society. Two processes have accelerated the world towards these, the development of information and communication technologies, and the dominance and success of the liberal economic ideology. Both forces, while modifying the dynamics of the economy, have created challenges and opportunities for all countries, and are today leading to the emergence of an effective "knowledge economy," knowledge becoming an important organizing principle for society. These processes have been further enhanced by the transit of a large number of countries to a democratic system. Of course, together with globalization, the world has also transited towards the rebirth of nationalisms, as expression of the desire to and need for preserving cultural pluralism.

In spite of the advances triggered by globalization and the opportunities it has created, many developing countries are facing enormous difficulties re: the demands of their societies while adjusting to the new dynamics. As a result of their inability to produce appropriate responses, the economic and social conditions in these countries can be characterized as dramatic.

An understanding of the many edges of globalization is essential to grasp the meaning of such a situation. In particular, it should be clear that among its most powerful agents are transnational conglomerates and corporations which effectively dominate a large fraction of the world's production of goods and services, trade, technology and finances. Such entities have more financial resources under their control than the total GNP of the

least developed countries. Their power and influence narrow the range of options and capabilities of weak national governments, when trying to implement consistent autonomous integrated economic, research and innovation policies.

In spite of the dependence and the severe restrictions to the degree of autonomy of national policies, there exists a potentially sufficient space, for local decisions, to influence on the distribution of income, the assignment of resources and the profile of international insertion, in other words, sufficient potential to formulate a valid strategy for sustainable development.

In light of the world situation, several authors have explored the limits of the present patterns of economic growth and its cultural, social and environmental consequences and future scenarios.

Hammond suggests a “global market” scenario, that considers the private sector as the motor of growth and the global economic integration, the motor of development. To reach it, it is then enough to provide the private sector all facilities and break all barriers to trade. This scenario considers that the private initiative and an expanding economy are the best ways to improve life and to provide opportunities and incentives, and estimates that within the next five decades, the world will have expanded its economy six times, providing prosperity without precedent to many social classes.

In this scenario, an excessive materialism, the existence of great inequities and the persistence of poverty are evident. Thurow has pointed out that “capitalism is shortsighted and cannot make the long term investments in education, infrastructure and research that are needed for its own survival.” Thus, a strictly market-oriented future, in the absence of important and deliberate interventions to mark the course of human destiny includes a large number of risks.

To improve this scenario, a fundamentally new outlook is needed. Machado considers that governments have overestimated the benefits of free market mechanisms. In his vision, the inequalities that it has generated have created an unbalanced economic process that tends to increase social problems and also the political pressures to reverse the liberalization process. He believes that a sustainable solution is the massive and accelerated economic growth of developing countries, on the base of the production of new environmentally adequate products and services. Such a solution requires creativity, leadership and international consensus, conditions that are considered absent and implies a review of orthodox policies and the international framework that supports them, in other words, a new industrial revolution.

In considering different scenarios, it is important to recognize the political and financial difficulties that a substantive modification of the situation implies, but at the same time recognize that, growth cannot follow the same pattern adopted by the advanced occidental economies in the past, there simply aren't sufficient resources and energy for that to happen and additionally the resulting pollution would destroy the planet.

Just as an example of the latter, climate scientists have predicted that the increase of carbon dioxide in the atmosphere would disrupt weather patterns, and indeed, annual

damages from weather-initiated disasters have increased over 40-fold; in 1999 such damages amounted to about 100 billion US Dollars. The consumption of chemicals has exploded, with about three new synthetic chemicals introduced each day. One of the most ominous chronic effects is that as the use of pesticides increased, so has the evolution of pesticide-resistant pests, amounting in 1999, to about 500 pesticide-resistant weeds and crop diseases and because of overfishing, the total world catch of Atlantic Perch decreased from 27 million kilograms in 1970 to about 1 million in 1999.

In the face of difficulties almost inherent to a “global market” type scenario, of responding to growing poverty and the gap between the rich and poor, certain political circles in the developing countries argue that no orthodox economic policy or its variations can satisfy the needs of society and that they would only continue the tendency of concentration of wealth putting at high risk the capacity of governance and therefore democracy. A possible result of the application of such vision, is depicted by a scenario of “isolated fortresses” also constructed by Hammond, in which the countries start to raise barriers to trade and the free circulation of persons. Although this might be a response to the present mismanagement of world affairs, it is a clear step backward in history. In such a scenario, it is possible to foresee that many countries would simply collapse and that the rich will constitute “islands of prosperity in an ocean of poverty.” As an alternative, Hammond constructs a scenario of a “transformed world,” constituting an optimistic view of the future, containing a society with power, of illuminated corporate actions and radical political changes. A scenario based on market forces, but not substituted by deliberate social choices, promoting competence but also viewing cooperation and solidarity among societies as equally important forces.

Rattner asserts that such a scenario can be reached by the creation of a more extended and enlightened leadership, thus he considers that a great effort must be made in the development of leaders for sustainable development, taking advantage of the recent evolution of new organizational forms which have created opportunities for the advent of participatory practices, consulting with the population and sharing with them the bulk of political and administrative decisions. In his vision human beings are never more fulfilled than when they are united in a group or community, each one aware and conscious about his/her personal commitment in serving the common endeavor. To this view, it should be added that an important element in motivating human change is what people believe is right and wrong. Questions that arise here are rooted in an ethical, moral, spiritual and a religious system, which must be integrated into development thinking.

Brown et al, construct a scenario for a sustainable world towards the year 2030 that considers an advance toward sustainability based on the collective deepening of the sense of responsibility towards earth and towards future generations. This scenario deals with several basic needs and a new economic approach, and calls for a transformation of priorities and individual values. This view is coincident with that of Guimaraes, which calls for the creation of “sustainable regimes.” Both calls are of course fundamental, in view of the present patterns of development and consumption

The dismal forecasts that can be derived from an extrapolation of present trends need not occur. Advances in science and technology, if supported by the necessary political

will and international cooperation, mobilized by appropriate policies can produce, substantial progress over the next years towards a sustainable world. As such, this contribution examines the role that science can play in a scenario of transformation to sustainability in developing countries. It suggests a set of policy objectives addressed to the creation and strengthening of scientific capacities that are needed to effectively contribute to such a transition.

## **2. Sustainable Development**

In 1987, the World Commission on Environment and Development recognized that the failure of man to live in harmony with his environment had changed and endangered the planet's life-supporting systems. The overexploitation of natural resources and the methods of production and life styles in industrialized countries have in effect caused severe pollution and degraded the environment. The Commission's report concluded: "We borrow environmental capital from future generations without any intention or prospect of repaying."

As a response to the challenges posed by the World Commission, national and international institutions, started conducting efforts to reverse environmental damage, create awareness, modify technologies, and adopt new economic and social measures. In the process, the concepts and practices of sustainability have been greatly enriched. As a result it has become clear that sustainable development is brought about by the capacities that a society can develop to transform, mobilize its potential, and reaffirm its cultural identity. Thus, sustainable development is not imported "turn key," it is mainly an endogenous effort. It requires fundamental changes in the way of thinking, living, producing, consuming, and forms of human interrelationships, in sum, it needs new political, administrative, social, and economic systems and regimes.

There are three particular dimensions, drawn from the above conditions, in the creation of endogenous capacities for sustainability that are crucial for the developing countries. They relate to human, infrastructure and management capacities. The first, the increase and improvement of the existing system of generation, transmission and use of knowledge, the second, the production of an accelerated development of the physical and telecommunications infrastructure, and the third, an increase of the efficiency of management at all levels, but particularly in the public sector.

### **3. A Scenario of Transition to Sustainability**

Sustainable development can be considered as composed of five closely interconnected dimensions: economic growth, social equity, preservation and adequate use of the environment, culture and governance. None of them by themselves constitute sustainable development. In considering a scenario of transition to sustainability, it should be clear that the problem is not just of saving the planet for future generations, but also of saving the planet's current generation.

Economic growth is the result of competitiveness. A country's structural competitiveness can be measured in many ways. The World Economic Forum uses eight indicators:

- Internal strength of the economy: the degree of macroeconomic behavior.
- Internationalization of the economy: the degree of the participation of the country in the international flows of commerce and investment.
- Government: the degree in which governmental policies lead to competitiveness;
- Finances: the behavior of capital markets and quality of the financial services.
- Infrastructure: the degree that the resources and systems serve the basic needs of business.
- Management: the degree in which firms are administered innovatively, responsibly and profitably.
- Science and technology: representing the technological capacity and the success of research.
- Human factor: the availability and qualifications of human resources

Considering these indicators, competitiveness, can then be defined as:

The capacity of the country, given its economic and institutional structure, of producing a sustained and high per capita economic growth in a given period of time.

An important vision of the paradigm of competitiveness is that of Bitar and Bradford. They view development as a structural transformation process. Instead of being characterized as continuous, economic growth is a discontinuous process led by the diffusion of technological change in the economy. Competitiveness is conceived as a project originated internally, as a way of moving society towards transformations and economic dynamics. In this way, competitiveness leads to a cooperative relationship among all economic and social sectors as the key of a growth process centered in the development of knowledge.

Competitiveness-based development, represents a very different direction to the doctrines of the past and the orthodoxy of the 1980s. National strategies of development come first, then they generate global growth and export. Growth is from the inside out and has a certain supply-sided nature. Orthodoxy sees trade from the point of view of demand and stable macroeconomic policies and the liberalization of trade in traditional patterns as sufficient conditions to generate growth.

The orthodox vision is centered in economic efficiency as the criteria for the allocation of resources. The new paradigm of competitiveness looks at the initiatives of economic agents that create new rules, thus creating opportunities and different ways of organizations. The market paradigm involves an automatic answer of the economic agents, whereas competitiveness involves interactive work between enterprises and other economical agents. The orthodox vision establishes the priority of the economy over policy, while the latter is required in the new paradigm.

Reaching high rates of competitiveness is therefore in the basis of economic growth, and a transition to sustainability in the developing countries demands the search of structural competitiveness, that is, to make institutions and enterprises and conglomerates competitive, as well as the national system under which they operate. The new paradigm is built on the idea that no market, sector, or industry is isolated from the world and that relative efficiency as well as efficacy are relevant to all the social actors.

The social equity dimension stems from the need of creating growth conditions that respect the individual and at the same time provide him/her with the conditions and opportunities to actively participate in them. In more recent times, the term sustainable human development has been introduced as a better expression of the search of equity in sustainable development, and in the view of some authors, should actually substitute this term, as it clearly identifies the subject of development.

This dimension must be understood in a scenario of transition to sustainability, as including aspects such as inter- and intragenerational equity, access to education and health, and a better quality of life. By attributing priority to education and health, the basic infrastructure conditions are created for the solution of the more complex social problems of society. Without clear and transparent policies and guidelines in view of a rapid transformation of the health and education systems, there are no chances to attain sustainability.

The world economy is in its way destroying the natural systems which support it. Thus the importance of the preservation and adequate use of the environment, as a key dimension of sustainable development. The environmental dimension plays a central role in this scenario, not only in terms of the sustainability of production and development patterns in the medium and long term, but also as a factor that may inhibit the access to specific markets, and thus an element that directly influences the effective competitiveness of nations and enterprises.

The roots of environmental degradation stem from social inequities and greed. In a scenario towards sustainability, the use of natural resources must be linked to a better distribution of wealth and some control over trade, technology and investment flows. At the same time, it must be considered that inequities will diminish if development policies are based on the concept of endogenous capacity building.

A basic dimension of a scenario of transition to sustainability is culture. It not only helps to create self-esteem in a society, but also contains elements that are determinant to create wealth. Landes, Yergin, and Stanislaw, starting from very different considerations come to the conclusion that cultural elements such as hard work, the passion for progress and for the creation of knowledge, are key sources of wealth.

The concept of culture does not only refer to the arts and the aesthetic aspects of life, but also to the ideas and values, the attitudes and preferences, and therefore to the behaviors derived from them. Particularly important today in this conceptualization of culture, is the concept and the practice of ethics. The controversies or perplexities that today invade the discussions on ethics are probably due to the fact that not only values have changed, but also the nature of ethics itself.

On the other hand, the destruction of nature's biodiversity, meets its parallel in the gradual loss of cultural diversity. Thus a scenario of transition to sustainability must include the defense and development of ethnic minorities, their traditions, including languages, religion, ways of life and music. It is important that individual and collective identity be nurtured, leading to a feeling of "belonging" to a community.

Today's democratic processes are exposed to the social pressure of growing poverty. They find themselves between the need of advancing in the institutional consolidation of democracy, and at the same time, promote growth with social equity, that is, to reconcile political democracy with market economy and social justice. Globalization and interdependence have particularly contributed to the complexity of the problems that governments must face and demand an improved understanding and management of complex systems.

This situation constitutes without doubt the central problem of governance, as in the framework of globalization and interdependence, in front of the risks of the lack of legitimacy of the political system, the deepening of socio economic problems, and the deficiencies of the state management, it must make democracy respond to the dangers and conflicts that tend to undermine the bases of legitimacy and the institutional operation of the political system, and simultaneously increase the institutional capacity of action and management of the state, that is, strengthen its capacity of articulating social interests and the adoption of appropriate decisions to solve problems of growth and social equity.

The concepts and practices of adjustment and governance, in a scenario of transition to sustainability, are related to those of modernization and the results of adopted policies. If modernization is accepted as that which covers an ample opening of the local economies to external trade and to international capital flows, a government reduced in its functions to only the essentials, but capable of maintaining price stability, and a structure favorable to the private activity, then, there should be no doubt that with the adoption of adjustment policies, fundamental steps have been taken in many developing countries.

If however, a definition of modernization includes the existence of effective mechanisms of democratic participation, coordination among private economic agents and of these with government, the streamlining of extreme social conflicts and the preparation of a sustainable long term growth, there is still a long way to go.

-  
-  
-

**TO ACCESS ALL THE 37 PAGES OF THIS CHAPTER,**  
Visit: <http://www.eolss.net/Eolss-sampleAllChapter.aspx>

### **Bibliography**

Bitar S. and Bradford C. I. Jr. (1992). Strategic options for Latin America in the 1990s. In C. I. Bradford Jr., ed. *Strategic Options for Latin America in the 1990s*, 287 pp. París: BID/OECD. [An in-depth discussion on the paradigm of competitiveness and orthodox policies.]

Branscomb L. M. and Keller J. H., eds. (1998). *Investing in Innovation: Creating a Research and Innovation Policy that Works*, 516 pp. Cambridge, MA: MIT Press. 516 pp. [Review and discussion of recent policies adopted in developed countries to enhance innovation capacities.]

Caswill C. (1992). *Academies, Research Councils and Universities: Their Role in Modern Europe*, 66 pp. London: Academia Europaea. [A review of critical issues about the role of scientific institutions in a globalized and market-oriented world.]

Clark W. and Kates R. W. (1999). *Our Common Journey: A transition toward sustainability*, 528 pp. Board on Sustainable Development, Policy Division, Washington, DC: National Academy Press. [An in-depth study on the way science can be used in order to respond to sustainability challenges in specific economic and social sectors.]

Gibbons M. (1998). *Higher Education Relevance in the 21st Century*, 60 pp. Paris: Contribution to the UNESCO Conference on Higher Education, 5–9 October. [A discussion of the role of universities in a world where the production of knowledge is taking many different ways and involving a diversity of actors.]

Hammond A. (1998). *Which World: Scenarios for the 21st. Century*, 306 pp. Washington, DC: Island Press/Shearwater Books. [Construction and discussion of three scenarios for the 21st century, from the perspective of a free market economy.]

Machado F. (1998). Administración eficiente de la innovación tecnológica en los países endesarollo. *Comercio Exterior*, 48(8), 12. [An overview of what could be a new industrial revolution, based on the development of new products, attuned to world environmental demands, produced by the developing countries.]

Oldham J. (1994). International scientific collaboration, 25 pp. ORSTOM/UNESCO Conference: *20th Century Science: Beyond the Metropolis*, September. [A critical review of the state and results of international cooperation and science aid.]

Rattner H. (1999). Leadership for sustainable society, 18 pp. Paper prepared for the W. F. Kellogg Foundation Leadership Forum, *Leading Change in the New Millennium: A Call to Action*, Washington D.C., November. [A discussion of the needs of creating a new leadership in the world, based on principles of sustainability and of the need of strengthening social cohesion through the traditional and new roles of non-governmental organizations.]

Thulstrup E. W. (1999). Promoting science driven economic development, 15 pp. Paper presented at the Bolivian Science and Society Symposium, Cochabamba, September. [A critical review of issues related to the need of promoting science and cooperation in developing countries.]

### Biographical Sketch

**Professor Carlos B. Aguirre** is a Bolivian physicist, President of the National Academy of Sciences of Bolivia, and also professor of policy and management in the Universidad Mayor de San Andres, La Paz. His present activities include membership or directive posts in several national, regional and international organizations of science. Between 1995 and 1996, he was the Executive Secretary of the Bolivian National Science and Technology Council. In the early 1990s, he directed a project for the monitoring of new technologies for the Andean Countries and was editor of the Andean R&D Newsletter. In the 1980s, he was Head of the Technology Department of the Andean Community Secretariat in Lima, Peru. In this period, he was also the Secretary of the Andean Council for Science and Technology and Secretary to the Andean-European Commission for Science and Technology Cooperation. Before joining the Secretariat, he was between 1978 and 1979, the first Director of Science and Technology, in the Bolivian Ministry of Planning. Between 1973 and 1978, he was the Director of the Physical Research Institute of the Universidad Mayor de San Andres, where he also held the positions of Director of the Research Planning Center and Secretary General. In 1969, he was appointed full professor at the Physics Department of the Faculty of Sciences. He has been an Associate Member of the International Centre for Theoretical Physics, in Trieste, Italy and visiting professor in Japan, Argentina, Colombia, Peru, Venezuela, the former Soviet Union, and Germany. Professor Aguirre is a member of (and has held a number of directive posts in) international and national scientific organizations, and professional societies. He has conducted consultancy assignments for UN organizations, bilateral cooperation agencies, international NGOs, and

others, in the fields of education, science, technology and innovation policies; he has worked in Austria, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Namibia, Mexico, Indonesia, Spain, Sweden, Switzerland, Tanzania, and Venezuela. He has received several distinctions and awards for his services to science and development. Professor Aguirre has published extensively in the fields of cosmic ray physics, science and innovation policies and planning, higher education, and environmental issues.

UNESCO – EOLSS  
SAMPLE CHAPTERS