Review of Sustainable Development Indicators. Case Study: Bolivarian Republic of Venezuela - Statistical Information for Year 2005

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*Abstract***:** This study is a review of sustainable development indicators, especially indicators framework proposed by the United Nations, and examines the particular case of the environmental quality matrix of the Bolivarian Republic of Venezuela in 2005. This matrix was used for calculating a second generation sustainable development indicator: the environmental quality index. This analysis includes the study of the relationships between economic, social and environmental variables and the classification of Venezuelan states in homogeneous groups according to the similarity that they present with the available information regarding those variables.

Keywords: sustainable development, environmental quality indicators, principal components, cluster analysis.

1. Introduction

Sustainable development is defined as a type of development capable of satisfying present needs without compromising the ability of future generations to meet their own needs. This definition was first used in 1987 by the World Commission of Environment of the United Nations, created in 1983.

Latin America is not immune to environmental problems. In 1978, begins, within the Economic Commission for Latin America and the Caribbean of the United Nations (ECLAC), a research program on environment and development, which contributed to understanding the relationships between environment and development.

The United Nations has been pioneer working the field of sustainable development, promoting the "Earth Summit", in which the international community adopted the Program 21 and Agenda 21: a plan for sustainable development, which must be measured through a set of indicators, with the aim of contributing to integrated decision making for it.

Despite the expressed need to devise a system for sustainable development indicators [16, 18, 21] there is confusion and disagreement about the characteristics that should have an indicator that can measure it. However there was consensus that it should incorporate economic, environmental, social and institutional issues. In relation to sustainable development and its planning, some authors [1, 7, 15] agree that it depends on the actions that are taken in cities and sustainable urban development emerges, whose mission is to promote balanced, equitable and sustainable growth of cities, through a democratic and quality planning.

In the Bolivarian Republic of Venezuela, there is the Environmental Quality Index (ICA from the Spanish "Indice de Calidad Ambiental") that has been proposed by the National Statistics Institute (INE from the Spanish "Instituto Nacional de Estadística") in 1998. The purpose of ICA is to express the relationship between the environment and the occupation of the territory based on the concept of sustainable economic growth with rational exploitation of the natural environment. The ICA incorporates information concerning the built environment and urban space as a scheme of territorial occupation; hence the environmental quality index is an indicator of environmental quality in a particular level of urbanism.

The methodology for calculating the ICA requires that all involved numeric variables are converted to a "modes" or "categories" system, and uses a weighting system that oscillates between 1 and 4. The result is the

allocation of the 23 Venezuelan States and the Capital District into a specific quality level that can be excellent, good, regular, bad and very bad.
In this research it was performed the statistical analysis of the variables included in the calculation of the ICA in 2005, and includes a set of new economic, social and environmental variables for the same period analysis. This study included descriptive analysis, principal component analysis for selecting the relevant variables, and cluster analysis for identifying homogeneous groups or clusters in the states, whose economic, social and environmental characteristics are similar; and then, they are compared with the classification of ICA proposed by the INE in 2005.

2. Sustainable Development and Environmental Sustainability Indicators

The concept of development has been tied to the study of the production and consumption growing process, as a result of the accumulation of capital and knowledge, vision which corresponds with the economic growth concept, but not necessarily with development.
Actually, development is conceived as a multidimensional process, which requires economic growth, high industrialization and services levels that enhance life quality, with safe and permanent access to food, health, education, drinking water among others.
In 1960's, it was incorporated to the concept of environment the development concept and merging this two concepts it rises the idea that economic and social development should be achieved in order to minimize negative effects on the environment; and then it emerges the *sustainable development* concept.
Sustainable development is one that can fulfill the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs. This definition was first used by the World Commission on Environment and Development (1987) [23]. This type of development has four main components: economic, social, environmental and institutional.
Agencies such as the United Nations (UN), Organization for Economic Cooperation and Development (OECD) and World Bank have played a fundamental role in sustainable development. These organizations have proposed a series of indicators for measuring the degree of sustainable development, in order to guide decision-making and macroeconomic planning in savings and investment, incorporating the environment as capital and its destruction as an agent of decapitalization.
However, there is no internationally accepted standard methodology that allows comparisons and interpretations with respect to sustainable development. There exists a classification of sustainable development indicators, based on the composition of simple or complex variables [18].

- **First Generation Indicators (1980 - present):** They define the environment or environmental sustainability indicators, such as air quality, water pollution and deforestation indicators, among others.

- **Second Generation Indicators (1990 - Present):** Represents the multidimensional approach to the sustainable development and these indicators are solid, synthesis of two, three or four dimensions of sustainable development, but they fail to be fully binding and some of these dimensions shows sectoral profile.

- **Third Generation Indicators:** The third-generation produces binding indicators that with few figures show the state of sustainable development. This third generation is the current challenge, which incorporates major global initiatives. The design and evaluation of the public policy effectiveness makes them really valuable scientific developments.

Notably, the world and especially Latin America is among the first and second generation of indicators, while recognizing the need to move forward in a cooperative way in developing the third generation**.**
In Tables 1 and 2, there are shown sustainable development indicators proposed by the OECD and themes and sub-themes indicators frameworks proposed by the UN in 2001, both of great importance for all countries around the world interested in the measurement of sustainable development. It was performed a pilot study for testing these indicators in 22 countries (six are from Latin America and the Caribbean) that participated, according to the following list:

- Europe: Austria, Belgium, Czech Republic, Finland, France, Germany and United Kingdom.
- África: Ghana, Kenya, Morocco, South Africa and Tunisia.
- Asia and Pacific: China, Maldives, Pakistan and Philippines.
- America and the Caribbean: Barbados, Bolivia, Brazil, Costa Rica, Mexico and Venezuela.

Table 1. Sustainable Development Indicators proposed by the OECD - 2001

Objective		Indicator
Natural Capital	Air Quality	Greenhouse gases emissions Index and CO_2 and NO_2 emissions
	Water Quality	Water use Intensity (extraction / renewables resources).
	Energy resources	Energy resources Consumption.
	Biodiversity	Protected area (percentage of total area)
Economic Capital	Production	Net capital stock Volume
	Technological Change	Multifactor Production Growth rate
	Financial Assets	Net foreign assets and current accounting balance.
Human Capital	Human Capital Stock	Proportion of population with secondary or university education
	Investment in human capital	Expenditure on education
	Depreciation of human capital	Unemployment rate and level
Meeting Needs	Consumption	Household final consumption expenditure. Intensity of municipal waste generation
	Income distribution	Gini Coeficient
	Health	Life expectancy at birth. Urban air quality
	employment	Ratio employment / population
	Education	Participation Rates

Source: Lavandeira et al (2007). Translation from original document “Sustainable Development: the critical issues”

Table 2. Indicators by theme Framework. UN Commission on Sustainable Development. Extracted from the Report "Indicators for Sustainable Development, Framework and Methodologies" Made in March 2001

Social		
Theme	**Sub-theme**	**Indicator**
Equity	Poverty	Percent of Population Living below Poverty Line Gini Index of Income Inequality Unemployment Rate
	Gender Equality	Ratio of Average Female Wage to Male Wage
Health	Nutritional Status	Nutritional Status of Children
	Mortality	Mortality Rate Under 5 Years Old Life Expectancy at Birth
	Sanitation	Percent of Population with Adequate Sewage Disposal Facilities
	Drinking Water	Population with Access to Safe Drinking Water
	Healthcare Delivery	Percent of Population with Access to Primary Health Care Facilities Immunization Against Infectious Childhood Diseases Contraceptive Prevalence Rate
Education	Education Level	Children Reaching Grade 5 of Primary Education Adult Secondary Education Achievement Level
	Literacy	Adult Literacy Rate
Housing	Living Conditions	Floor Area per Person
Security	Crime	Number of Recorded Crimes per 100,000 Population
Population	Population Change	Population Growth Rate Population of Urban Formal and Informal Settlements

Environmental		
Theme	**Sub-theme**	**Indicator**
Atmosphere	Climate Change	Emissions of Greenhouse Gases
	Ozone Layer Depletion	Consuptions of Ozone Depleting Substances
	Air Quality	Ambient Concentration of Air Pollutants in Urban Areas
Land	Agriculture	Arable and Permanent Crop Land Area. Use of Fertilizers. Use of Agricultural Pesticides.
	Forests	Forest Área as a Percent of Land Area. Word Harvesting Intensity.
	Desertification	Land Affected by Desertification.
	Urbanization	Área of Urban Formal and Informal Settlements.
Oceans, Seas and Coast	Coastal Zone	Algae Concentration in Coastal Areas. Percent of Total Population Living in Coastal Areas.
	Fisheries	Annual Cath by Mayor Species.
Fresh Water	Water Quantity	Annual Withdrawal of Ground and Surface Water as a Percent of Total Available Water.
	Water Quality	BOD in Water Bodies. Concentration of Feacal Coliform in Freswater.
Biodiversity	Ecosystem	Área of Selected Key Ecosystems. Protected Área as a) of Total Area.
	Species	abundante of Selected Key Species.

Economic		
Theme	**Sub-theme**	**Indicator**
Economic Structure	Economic Performance	PIB per cápita. Investment Share in GDP Proporción de la inversión en el PIB.
	Trade	Balance of Trade in Goods and Services
	Financial Status	Debt to GNP Ratio Total ODA Given or Received as a Percent of GNP
Consumption and Production Patterns	Material Consumption	Intensity of Material Use
	Energy Use	Annual Energy Consumption per Capita Share of Consumption of Renewable Energy Resources Intensity of Energy Use
	Waste Generation and Management	Generation of Industrial and Municipal Solid Waste Generation of Hazardous Waste Generation of Radioactive Waste Waste Recycling and Reuse
	Transportation	Distance Traveled per Capita by Mode of Transport

Institutional		
Theme	**Sub-theme**	**Indicator**
Institutional Framework	Strategic Implementation of SD	National Sustainable Development Strategy
	International Cooperation	Implementation of Ratified Global Agreements
Institutional Capacity	Information Access	Number of Internet Subscribers per 1000 Inhabitants
	Communication Infrastructure	Main Telephone Lines per 1000 Inhabitants
	Science and Technology	Expenditure on Research and Development as a Percent of GDP
	Disaster Preparedness and Response	Economic and Human Loss Due to Natural Disasters

Source: United Nations. Department of Economic and Social Affair.

Tables 3 and 4 show, in turn, the indicators used by countries participating in the pilot study and another set of new indicators that have been suggested by these countries.

Table 3. Selection of Sustainable Development Indicators Frequently Used

Unemployment Rate
Population growth rate
GDP per capita
Domestic per capita consumption of water
Land use change
Use of fertilizers
Ratio of threatened species to total native species
Ambient concentration of urban air pollutants
Emissions of greenhouse gases
Emissions of sulphur dioxides
Emissions of nitrogen dioxides
Annual energy consumption

Source: Lavandeira et al (2007).

Table 4. New Indicators Suggested by Countries

Incidence of environmentally related disease
% Population with access to health services
Crime rate
Incidence of street children
Urban green space
Ground water pollution
Ratio of mining area rehabilitated to total mining area
Area of specific ecosystems
Ownership of agricultural land
Genuine savings ratio
Traffic density
Release of GMOs

Source: Lavandeira et al (2007).

2.1 Urban Environmental Quality Indicators

Around sustainable development, it has come to believe that depends on the actions that are taken in cities, since, as urban areas, concentrate large numbers of people, and are complex systems that consume vast resources and generate multiple flows that have to be properly controlled. It can be talk about *sustainable urban development*, which should have, as critical mission, the promotion, through a democratic planning and quality the balanced, sustainable and equitable growth of cities.

Gabaldon [7] defines a *sustainable city* that one that allows continuous enhancement of the quality of life of its habitants within acceptable ecological conditions in urban areas, regional and global levels. Those cities that can provide a sustained improvement through time in quality of life of its habitants, making that the economic and social activities do not interfere in the ecological environment.

Efforts of different agencies are focused on improving the urban environment, promoting rigorous studies of the urban environmental quality to carry out strategic planning and integrated actions at local level. This defines a set of indicators to enhance the welfare of citizens in more energy efficient urban spaces, generating less waste or noise, integrating nature in the city and promoting informed and active participation. These are a type of sustainable development indicators that involve the study of urban spaces, understanding *urban environmental quality* as "the optimal conditions that govern the behavior of living space in terms of comfort associated with ecological, biological, economic, productive, social cultural, technological and aesthetic dimensions in space." [14].

The urban environmental quality should be measured from the following aspects:

- **Architectural-Urban**: related to the physical-space configuration of the city, with the equipment, functionality and infrastructure services, aesthetic aspects and urban image.
- **Physical-Natural**: related to the physical variables that are involved in comfort and safety of residents.
- **Economic, Social and Cultural**: concerns all those aspects that involve humans and their actions on the urban space.

For developing urban environmental quality indicators are usually used two methodological schemes: a scheme focused on the development of a causal framework through the “Pressure State Response” model [18], and other more operative mathematical scheme where the causal relationships are not evident.

These schemes have been developed by some pioneering initiatives led by the OECD, UN and World Health Organization (WHO), which include the Urban Indicators Program and Healthy Cities indicators which aim to establish a observatory network that allows control, monitoring and evaluation of the Habitat and Agenda 21.

3. Environmental Quality Index (ICA) of the Bolivarian Republic of Venezuela

In the Environmental Statistics Department of the National Institute of Statistics (INE), it was designed and tested an environmental quality index (ICA), which purpose is to express the relationship between the environment and the territory occupation based on the concept of sustainability, which denotes economic growth with the rational natural environment exploitation [8,9].

Under the ICA framework, it is defined the environment as the set of physical, chemical, biological, economic and social factors that can influence on human beings and human activities [8,9].

In this regard there are several types of environment:

- **Natural Environment:** Made up of natural areas such as forests, oceans that operate without economic or energy flows directly controlled by humans.
- **Modified or Artificial Environment:** Includes everything that man has created to live more comfortably and to defend from the weather, including systems operated by fuel (oil, gas, coal, among others).
- **Domesticated Environment:** Includes forest exploitation, artificial lakes, cultivated fields, animal farms. These sites are managed to promote food and fiber production, for recreation, education and other human uses. Includes solar subsidized systems, but this source is amplified by man controlled energy in the form of manual labor.
- **Social Environment**: Includes a number of factors that make posible the community life such as cultural, political, religious, legislative, educational, familial, economic, aesthetic, scientific and technological developments.

Additionally, the built environment as a scheme of territorial occupation can lead to perception differences of urban in diverse regions of the country, understanding *the city* as the place with the highest level of human coexistence. So, in ICA, the concept of poverty is attributed to the inadequacy and lack of urbanism and the intention is to get a number that measures the urbanism level in an environmental unit.

The rural term assumed in the Venezuelan social context describes those areas of the country dominated by towns with fewer than 2,500 habitants, characterized by extensive use of land, whose habitants are attached to traditional trade and subsistence patterns, and where agricultural products obtained from his interaction with the natural environment is the commercial basis [9,10].

3.1 Specification Summary for Environmental Quality Index (ICA)

The ICA is an indicator used for measuring the patterns and characteristics of urban reality in Venezuela. For creating the data matrix it was provided the aggregation of a number of statistical measures able for characterizing urbanism levels in the autonomous geographic spaces of the country, being defined two information categories:

- **Information relating to the physical-natural or Subsystem I**: describes the major characteristics of the natural environment occupied by human settlements.
- **Information concerning the activities of human occupation:** It is divided into two categories:

Subsystem II. Quality of infrastructure and basic services that support the activities of the population on the natural environment.

Subsystem III. Characteristics of occupants, referring to the socio demographic profile of the population.

For calculating the score of the ICA it is summed the scores obtained in each subsystem, as follows:

$$\text{Total Score} = \text{Score in Subsistems I} + \text{II} + \text{III}$$

Each subsystem can get a maximum score of 100 points. The maximum total ICA score can be 300 points, which represents the utopian limit of the sustainability term or the "ideal Urbanism" scheme.

The ICA taxonomy is given in Table 5. These five classes can be regarded as anthropology classes, classes 1 and 5 are extreme in socio demographic and quality of the urban landscape terms, and class 3 suggests the existence of a little industrialized traditional lifestyle probably in transition.

Table 5. ICA taxonomy

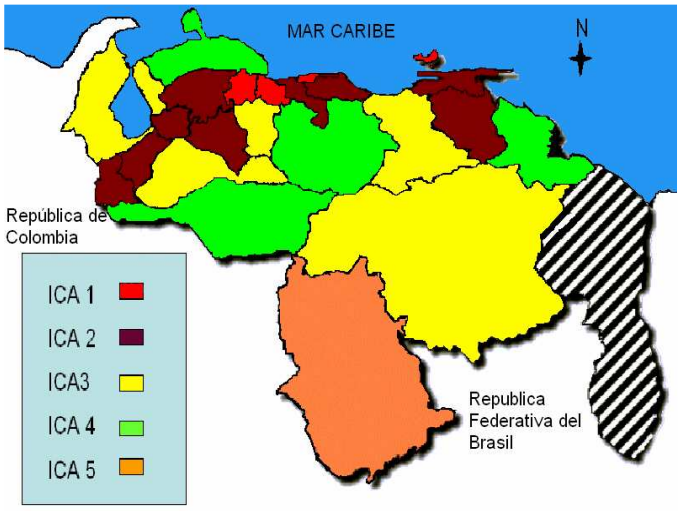
ICA	Environmental Unit Rating
1	Excellent
2	Good
3	Regular
4	Bad
5	Very Bad

In table 6 it is shown the Venezuelan states classification according to the ICA calculation made by the INE for 2005 according to the taxonomy presented in Table 1. In this classification can be observed that the Distrito Capital and the states of Carabobo, Nueva Esparta and Yaracuy have an excellent urban environmental quality, while the Amazonas State is classified with a very poor environmental quality, which means that the score in the ICA should be minimal.

Table 6. Venezuelan States Classification in 2005

ICA	States
1 - Excellent	Distrito Capital - Carabobo Nueva Esparta - Yaracuy
2 – Good	Aragua Lara Mérida Miranda Monagas Portuguesa Sucre Táchira Trujillo Vargas
3 - Regular	Anzoátegui Barinas Bolívar Cojedes Zulia
4 – Bad	Apure Delta Amacuro Falcón Guárico
5 – Very Bad	Amazonas

Source: Environmental Statistics Department - INE



Source: Environmental Statistics Department - INE

Figure 1. Venezuelan Map with States distribution and their respective ICA for 2005.

3.2 Principal Component Analysis: Proposals on Environmental Quality Matrix 2005

The Environmental Statistics Department of the National Institute of Statistics of Venezuela (INE) have provided the data matrix used in 2005 for calculating the Environmental Quality Index (ICA), which contains information on 31 variables (economic, demographic, environmental and social variables) measured in different states of Venezuela. Additionally, in this work it has been incorporated 6 variables for the same year under study that may help to improve the approximation of the Venezuelan ICA to the indicators proposed by organizations like the UN and OECD. These new variables are: life expectancy at birth, production of solid waste, total reported crimes, occurred fire, area affected by the fire and area of forest plantations.

The statistical data analysis was done using the computer program SPSS version 15.0. The analysis is performed for each subsystem of the ICA and in several stages: descriptive analysis, principal components analysis and cluster analysis [17].

In the exploratory analysis it was detected outliers in many variables, usually in the States of Amazonas, Delta Amacuro and Bolivar, as well as the Distrito Capital. It is also important to note that the multiple imputation procedure was performed using the average in the variables where there were few missing values.

From the observation of the correlation matrix it can be distinguished groups of variables that can characterize some areas of Venezuela in the following manner, but the highlight is that some variables such as mean temperature, sewage disposal, electricity, number of days of rainfall, number of average days of sunshine, area of forest plantations and wood plantations by state, have near-zero correlations with other variables; so it is suggested to remove them for the principal component analysis. Removing them, it is reduced the number of variables to 22.

Before the principal component analysis it was performed Bartlett's test of sphericity (see Table 7), which contrasted the of correlation matrix similarity to the identity matrix. Evaluating the significance of this test it was concluded that the correlation matrix shows correlation coefficients different from zero and this indicates that the variables are related. Then, it makes sense to perform principal component analysis.

Table 7. Bartlett's test of sphericity

Bartlett's test of sphericity	Aproximated Chi Square	546.911
	d.f.	171
	p value	.000

For obtain the principal components it is used the correlation matrix, since it eliminates the effect of measurement units and scales of values. For deciding how many components should be retained it is studied the variance explained criterion, average criteria and the graph of sedimentation. Finally, it is decided to retain the first seven principal components for explaining the 89.37% of the total variation of the original data. Interpreting the first two elements it can be found:

- **First component**. It explains the 40.06% of the total variation of original data. Is a Human Development Index (HDI) component, because is the variable that is most related to it. However, this component opposed the states with higher population density, life expectancy, living standard, school attendance, aqueducts, critical overcrowding household, vehicle fleet, waste solids and total crimes reported, to those states whose population is employed in agriculture, where is highest poverty rate, infant mortality and average parity of women under twenty years.

- **Second Component**. It explains 15.60% of the total variation of original data. It can be interpreted as a component of road network. It is opposed the road network variables, number of reservoirs, Areas under special administration regime (abraes), occupancy rate of the land and area affected by forest fires, to the aqueducts variables, population density, living standard and fires.

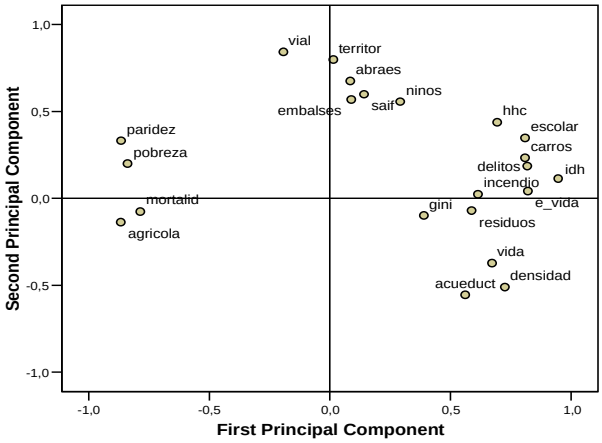


Figure 2. Variables respect to the two principal components

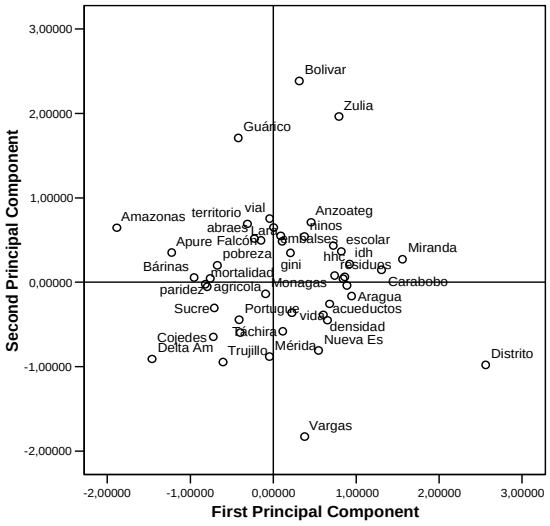


Figure 3. Joint Representation of States and variables respect to the components

It is very important to represent graphically the arrangement of the variables and the states in these two components. Thus, the observation of Figure 3 can highlight the following:

- Carabobo, Miranda, Aragua and Nueva Esparta are states that are associated with high density of population, living standards, solid waste, vehicle fleet, increased life expectancy and HDI, as well as the States where occur more fires and aqueduct percentage, indicating that there is access to drinking water. Distrito Capital and Vargas State suggest features similar to those described above.
- The state of Zulia, that in the descriptive analysis, has shown the highest school attendance and truancy and households in critical Overcrowding, is projected at some distance from these variables, but the Anzoátegui state could be associated with these characteristics.
- States of Zulia, Bolivar and Guárico appear closely related to second component, and are opposed to Vargas State and Distrito Capital. These 4 states and the Distrito Capital, have special characteristics that make them different from the rest.
- States of Amazonas, Apure, Barinas, Cojedes, Delta Amacuro, Falcón, Lara, Sucre and Yaracuy are associated with areas under special administration regime, a large percentage of the population employed in agriculture, higher proportion of the population in poverty, the mortality rate is higher and women under twenty years on average have more children than elsewhere in the country.
- States of Táchira, Mérida, Trujillo, Portuguesa and Monagas can be interpreted as agricultural States.

For detecting atypical cases it was used the principal components method suggested by Barnett and Lewis [2], which involves making a box diagram with the last principal components.

Doing graphics for the components 21 and 22, there are atypical cases that correspond to the states Yaracuy, Monagas, Cojedes, Falcon and Sucre. In general these states could be associated with a high percentage of population employed in agriculture, poverty, infant mortality and average parity in women under twenty years.

3.3 Cluster Analysis. Classification of homogeneous states

The cluster analysis is an exploratory multivariate statistical technique that allows the classification or data array elements grouping using similarity or distance measures, depending on the values found in the considered variables.

In this research it is conducted hierarchical cluster analysis using Ward method and squared Euclidean distance, using the same variables that were used in principal component analysis but typified or standardized.

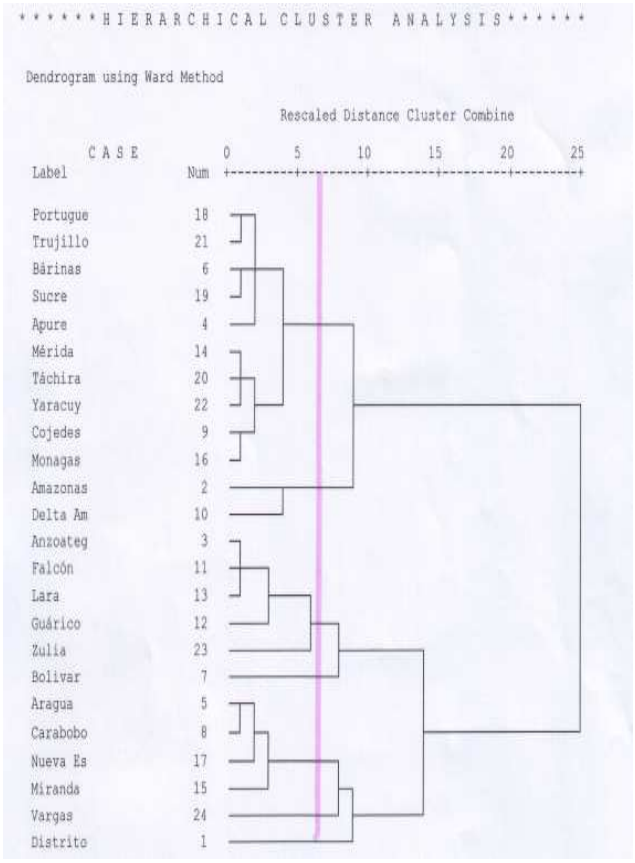


Figure 5. Dendrogram

Looking at the classification tree or dendrogram (Figure 2), and drawing a vertical line at the approximate distance of 7, we distinguish the following groups or clusters:

Table 8. Classification of States in Homogeneous Clusters

Cluster	State
1	Apure Barinas Cojedes Mérida Monagas Táchira Trujillo Portuguesa Sucre, Yaracuy
2	Amazonas, Delta Amacuro
3	Anzoátegui, Falcón, Guárico, Lara , Zulia
4	Bolívar
5	Aragua, Carabobo, Miranda, Nueva Esparta
6	Vargas.
7	Distrito Capital

This classification does not match the one made calculating the ICA in year 2005 (see table 2) and is closer to the Venezuelan reality.

4. Venezuela and the indicators proposed by the UN Sustainable Development Commission

In 2001 the Sustainable Development Commission of United Nations presented a framework of indicators for social, economic, environmental and institutional issues, in order to serve as a guide in decision making and planning of the countries [21].

In the Venezuelan case, there are registered important measures of variables and is done the calculation of some indices in the context of this proposal, most of which are included in the calculation of the ICA. However, it is interesting that there are various aspects, measured by various agencies, compiled by the INE and presented in the Statistical Yearbook of Venezuela, which have not been taken into consideration, such as: Provision of health, Literacy, Air Quality, Agriculture, Drinking Water and Water Quantity, Economic Structure, Communications and Science and Technology.

5. Conclusions

In the context of sustainable development and the participation of international agencies like UN, it arises the need of measuring the development degree of countries, involving in the indicators framework social, economic, environmental and institutional issues.

Within the proposed indicators for measuring sustainable development, there are included environmental quality indicators, however, the social, economic, environmental and institutional dimensions of the countries around the world are different, implying that these methodologies can not be applied in one way only or under the same conditions. That is why in different regions and countries are emerging efforts for measuring sustainable development through a system of indicators that are adapted to their own conditions.

In Venezuela it is used the environmental quality index (ICA) that is a second generation indicator, which involves three of the four dimensions of sustainable development for its calculation. The ICA measures sustainable development through the social, demographic, environmental and urban (built environment) information of the Bolivarian Republic of Venezuela States. The fact that ICA has incorporated information related to urban planning and infrastructure (built environment) means that the environmental quality index is measuring the patterns and characteristics of different levels of urbanism, and this index is in fact an urban environmental quality index.

In Venezuela, as in many other countries, not all states are urban, rural states also exist, so the methodology for calculating the ICA is inconvenient when is used for measuring the environmental quality of all states in the same way. Other methodology is recommended for these spaces that do not have great infrastructure, but emphasizing other features. For example, the state of

Amazonas, which is located at the south of the country and possesses the Amazon Rainforest, is a state under special protection regime as well as its flora, fauna and indigenous people.

For the statistical analysis of the environmental matrix of Venezuela for the year 2005, the variables were analyzed with the original measurements, i.e. not converted to qualitative variables, or mathematical transformations were not applied to them. In the original matrix there was information available for 31 variables and 6 new variables were added, most of which contributed to the clusters formation of homogeneous states.

Principal components analysis has reduced to 7 principal components the information provided by the studied variables, with minimal loss of information: in this case, almost 90% of the total variation of the original data is explained by the 7 components.

Furthermore, with the Ward method application, it was identified 7 clusters or homogeneous states groups, which do not coincide with the classification given by the ICA in 2005.

It is proposed for future research, using only numeric variables in the calculation of ICA conserving their origin, and try to find a new weights and classification system that allows an closer to reality allocation, and that include information concerning the institutional or governance for sustainable development.

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