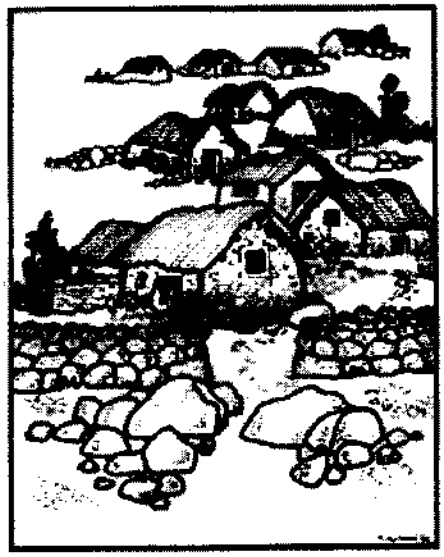
MOUNTAINS ECOSYSTEMS

ADVANTAGES THAT CONTRIBUTE TO THEIR DEVELOPMENT

Mario E. Tapia and Juan Torres



Andean Mountains
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1. INTRODUCTION

Actually, the environmental conditions at the mountains regions generate serious difficulties for the development planning to the governments in the countries that include these ecosystems. Mainly, when they constitute a significant percentage of their territory – as it happens in the central Andean countries like Ecuador, Peru and Bolivia, in the Himalayas and some mountain areas in Africa and East Europe. And, further more, when the number of inhabitants of these regions is important.

However, this situation has not always happened. In history, important kingdoms and empires had their birth in the mountains, from where people could manage resources as important as water and food production. In that sense, the American cultures as the Aztec and the Inca had their origin in mountainous regions and from there they created big empires, based on the security of producing foods. Tapia, 1993.

The mountains at the present time, due to factors like the heterogeneity, fragility, inaccessibility and complexity of their ecological, social and economic conditions should be recognized in the first place in this work context and to be good to solve the topics of the development associated with those problems. Carson 1992, Jodha, 1992.

One of the first steps before proposing intensification on the use of the natural resources is to recognize that the mountains do not present the homogeneity of the low lands and flat areas. In this respect, the use of classification methodologies for the climate, soils and the agroecologic distribution does not recognize the micro climatic variations, the effects of the soils' contour, nor the potential variable that are the crops and cattle raising that have been tamed in these atmospheres. Besides the mining, energy, tourist resources, what has hindered the possibility to propose their development, when not considering the variables conditions mainly to the level micro that are given in the mountains, in those near ones to the tropic.

2. THE MOUNTAINS

Per millennia, the mountains have evoked powerful emotions (fear, horror and reverence) among those that have lived without a clear vision of them. For the indigenous populations of the different continents, the mountains were and are gods or places where they inhabit, besides they are also places where they lived harmoniously in most of the cases. For other cultures they are symbols of the human ambition. However, there is not a lot of conscience about the critical natural services that the mountains provide, and still less about the life exceptionally rich and complex that they harbor. Contrary to the oceans or rainy tropical forests, the mountains still do not possess a scientific discipline of themselves and/or a well-known movement that diffuses the big threats that they face ecological and culturally, this means, the mountains do not have a Jacques Cousteau that defends them.

For most of the world's population, except for those who have a recreational interest or religious in them, the mountains are marginal ecosystems (see the table). However,

today we have institutes like the International Center for the Integral Mountain Development (ICIMOD) in Kathmandú, the Mountain in the United States and the Consortium for the Andean Development (CONDESAN) at The Andes as a representative for Latin America of the Initiative global Mountain Forum.

The mountains, considered as "the bones of the earth" or as marginal lands, have become a main topic on very important debates mainly in this new millennium as biodiversity centers, sources of water (better called towers of water), sacred places and also places with great potential in tourism.

Due to the different heights with regard to the level of the sea, the mountain systems present different soils or height areas. They also have different climates and soil types and diversity of wild and cultivated plants and of wild and domestic animals. In small distances we can find sheltered, cold, temperate or humid places. On the other hand, the mountains are barriers that prevent the pass of big wind currents. These characteristics mentioned are of the mountain ecosystems in the planet that cover 20% of its surface and in which the 10% of the world population's live (Figure 1).

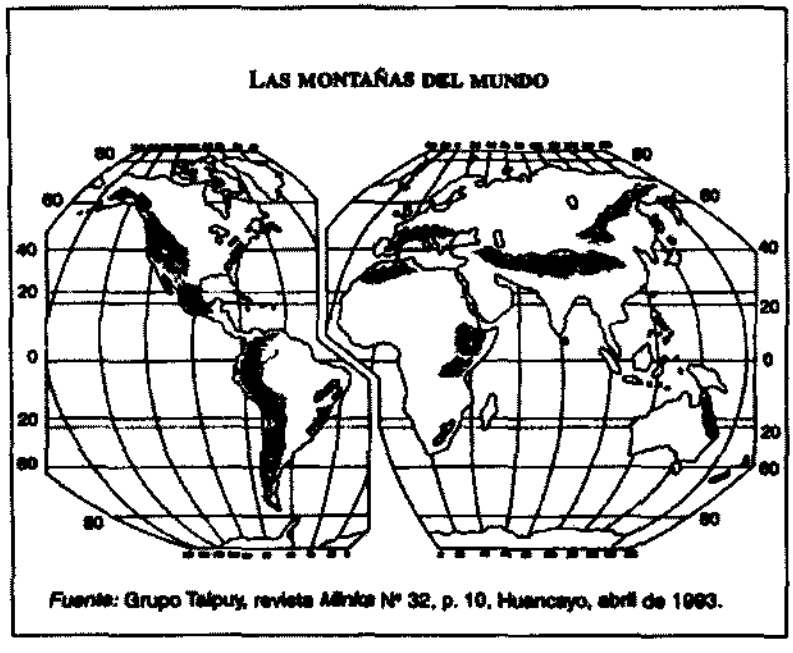

Figure 1. Mountains of the World

Also, two thousand million people depend on the mountains for their feeding, hydroelectricity, wood and mineral resources. That is to say, practically near half of the inhabitants of the earth and a great part of it depends on their biological diversity and on the fresh water of the mountain basins. It can be mentioned that approximately 80% of the sweet water of the world come from the mountains (Carlier 1996).

Due to their abrupt slopes and the higher exhibition degree to wind, rain and snow compared to the low lands and plains that surround them, the mountains are subjected to the more intense environmental pressures. At the moment the mountainous environments are seriously threatened. In Europe, almost half of the forests, many of them in mountainous regions, are victims of serious damages due to contamination, including the sour rains. The natural erosion and the outcome of the

pruning of forests as well as the faulty handling of the lands, it is driving to an increase of the sedimentation on the rivers and the decrease of local productivity.

In mountainous regions as the Himalayas, the Andes and the high lands of Ethiopia, the poverty is intense and the cultures and traditional lifestyles are in danger. There are diverse problems in health, including breathing illnesses and diarrheas in the tropical areas, and the incidence of skin cancer in the northern regions. (Fig. 1.)

It is necessary to maintain the mountainous environments under the conditions most possible next to their original situation in order to maximize the conservation at world, national and local level. When the frontiers between countries cross the mountain ranges is important to establish international cooperation agreements to protect them.

The high-priority actions are:

- The maintenance of vast surfaces in their natural state.
- The execution of programs to restore the mountain forests, to improve the handling of prairies and to foment the recovery activities.
- The establishment of wide social programs for the mountains' inhabitants.

It is indispensable to support the work of the Mountain World Net that serves as nexus among the current centers dedicated to the mountains and the matters related to the topic, with the purpose of favoring the conservation of the mountain regions.

Source: UICN-PNUMA-WWR 1991.

THE BIODIVERSITY

Defined as "The entirety of the genes, the species and the ecosystems of a region [2]", it constitutes the current wealth of the life in the Earth, product of hundreds of millions of years of evolution.

Along the time, human cultures arose adapting to the environment by means of the discovery, use and modification of the local biological resources. The biodiversity was built by the local plants and animal variety domestication and hybridization[3].

The study of the biodiversity is very associated to another discipline: the biotechnology and this to genetic engineering, reason for which the most interested in the topic are to be the big transnational laboratories.

Diversity of Species

A sample of the biological diversity is the enormous listings or big figures that give us a reference idea of the number of species registered in the world until today.

3. MOUNTAINS AND BIODIVERSITY

These are two relatively new concepts in our means. Hardly ten years ago very few people spoke about them and today they are an important part of the environmental calendar. Both were a section in the calendar Meeting at Rio (June 1992) and there have been many subscribed important conventions about the matter, particularly about biological diversity, very much associated to one of the

branches of the most avant-garde technology in the moment (together with the computer science): the biotechnology.

There is no doubt that the topics as mountains and biodiversity will be fundamental in the world during next millennium, and that once again, like in other occasions of our history, the natural resources will put these regions in an important place of the world's scene.

BIODIVERSITY IN PERU

Peru is among the countries considered as of huge diversity and the numbers that are handled speak of between 17 to 50 thousand species of plants, of which 15,000 are in the mountain (see Table 2 and Figure 6). Among these, the cultivated plants are as much as 150 to 200 species and 1,200 wild species of plants are for different uses (medicinal, textile, industrial). All this situates us in first level on the world's scene of the natural resources again, as it was it before with the guano, the rubber, the anchovy or the coca.

COUNTRIES WITH GREAT GENETIC DIVERSITY OF CULTIVATED VARIETIES

At the present time, a great expectation exists at world level about what the countries with great biodversity and centers of origin of cultivated plants would do with their natural ecosystems. These countries with mountain regions are Ethiopia, Kenya, Nepal, Mexico, Peru, Bolivia, Ecuador, and Colombia, natural habitats for species like potato, corn and beans.

4. ADVANTAGES OF THE MOUNTAINS FOR THE PRESENCE AND CONSERVATION OF OUR BIODIVERSITY

The mountains are very diverse ecosystems. Being conjugated in them many microclimates. The Andes in Peru – of 390,000 km^2 – hold, 28 climates in a short distance of the 32 climates for the whole planet according to the Thornthwaite system. This makes difficult the extrapolation of the data generated by a meteorological station at 2,000 m.o.s. for places located at less than a kilometer of distance but on the 3,000 m.o.s. In a similar way, the daily variations are very wide, for example, temperatures of 5-8°C at 4-5 o'clock a.m. and of 22-24°C at mid morning in a day.

On the other hand, the soils constitute real patches one after the other, with variations in their percentages of organic matter, depth and slope. This added to the microclimates conforms a microhabitat mosaic in which the genetic material of the alive beings extends all its potentiality expressed in a leafy biological diversity, vegetable, animal and of microorganisms. As the culture is linked to the man's relationship with their environment, it is not casual that within The Andes it has been developed a great cultural diversity that has guaranteed the conservation of the high ecological complexity, and of the biodiversity that these store. Because we may not forget that in our country, according to Holdridge, 84 of the 104 life areas have been identified for the Earth.

DIVERSITY OF HABITATS AND RURAL PRESERVERS

Today exist many indications that take us to conclude that the mountains' peasants and farmers have known how to use and to preserve the great biological diversity for

more than 5,000 years. The in situ conservation has been, until the moment, the most effective strategy to guarantee the maintenance of the immense existent genetic material, so valuable for the alimentary security not only of the Peruvian population but also of the whole humanity. In The Andes' case, an innumerable group of tuber, root, grain, leguminous, cucurbit, vegetables and fruit-bearing trees varieties as: potato, ocas, ollucos, mashua, sweetpotato (yam), maca, yacón, arracacha, achira, corn, queñua, kiwicha, cañihua, bean, peanut, pallar, tarwi, caigua, pumpkins, wild tomato, guava, pacae, chirimoya, and papaya have in the farmers and conservacionists, and in those of the Westerner and Oriental slopes, the best guarantee of their in situ conservation[4]. This factor, together with the great microhabitat diversity, characteristic of the Andean mountains, are part of the big advantages that have these ecosystems for the presence and conservation of the great biodiversity that it is stored in The Andes.

It Is Necessary to Know How to Manage the Advantages

Any strategy for the administration of our nature will take into account its main characteristics: the climatic uncertainty, the droughts and the excesses of water, the biological and cultural diversity, as well as the fragility. These features should not be considered as problems but as work conditions and inclusive as advantages, mainly the diversities; and it is not to fight or to combat against them, but rather of to cohabit and to optimize their variations.

It is true that such a diversified nature also demands a great variety of alternatives, such as, the generation of administration systems for basins or of diversified production systems (systems agro-forest-pasture). Having a so diverse and uncertain one environment, a same or higher number of appropriate answers should be given to our possible situations. One person can affirm, then that "the only control for the variety is the variety itself" or that "the variety can only absorb the variety" (Earls 1989).

THE GENETIC RESOURCES

There has been a series of species of enormous importance that have been tamed at mountain ecosystems of the world (Fig. 2.). For these the CIID and the ICIMOD organized in 1987 an international workshop on The Mountain Agriculture and the genetic resources of crops, Riley et. al., 1990. The conclusions of this workshop include a bigger approach among the technicians and the development experiences had in the mountains.

Conclusions of the Workshop at Kathmandu, 1987.

- To circulate a bilingual circular letter that relates and informs of the advances achieved in the mountains in the topics about handling of natural resources.
- To make available the extensive agroecologic database that each region has accumulated.
- Exchange of different scientific disciplines among the mountain regions.
- Exchange of phytogenetic resources among the mountain ecosystems.

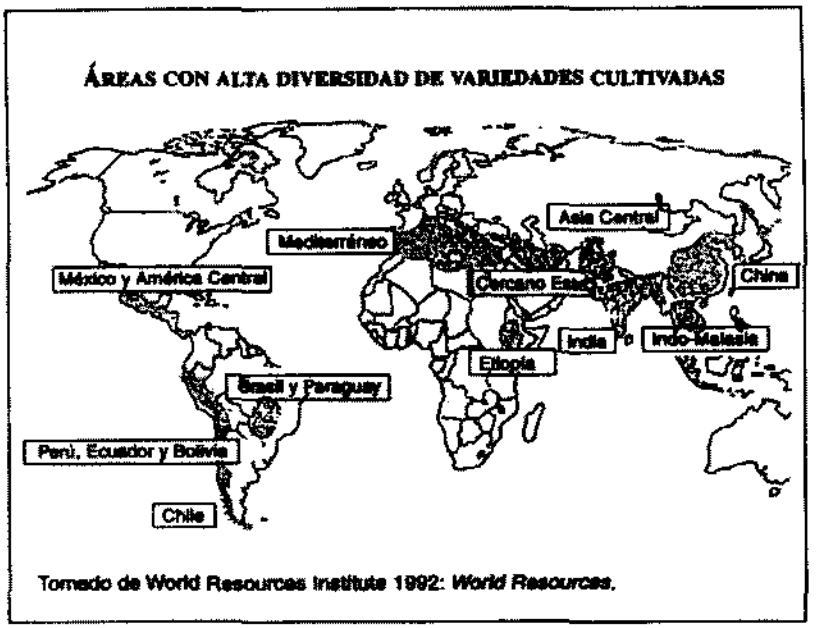

Figure 2. World areas with high concentration of cultivated varieties

For example in The Andes, the prehispanic populations from Colombia, Ecuador, Bolivia and north of Argentina and Chile, also tamed a series of vegetable species of potato and corn, and animals, contributing in this way to the solution of the nutritious problem in the world.

Other Andean tubers as the oca, olluco, mashua; grains of high biological value as the quinua, amaranth, cañihua; leguminous equivalent to the soya like the lupinus, doddering or tarwi; fruit-bearing and medicinal plants, as well as a high number of native forage species, only wait their time to offer to the world an improved nutritious alternative (Chart 2).

The source and genetic base for taming these species was the enormous vegetable biodiversity that their populations found, where the genius and the dedication of the farmers' generations knew how to choose the appropriate species and to detect the most convenient changes. This diversity still persists and what has not been recognized sufficiently is that the conservation of that genetic base is what allows the selection of new varieties that in homogeneous atmospheres and with an intensive use of energy allows high productivity and bases for the plant improvement programs.

These plant genetic resources are considered the true bank of gold that is claimed it exists in the Andean countries, as taxpayers to the alimentary security of the planet (Tapia 1993).

The species called domesticated have varied some of their characters along a process of thousands of generations and have been selected from their old plant relatives that are still preserved in these ecosystems; these are those that are in more risk of getting lost. From there, a double preservation effort is required for the plants: for domesticated and old related plants.

In the animal kingdom, mainly in The Central Andes of Peru and Bolivia, was tamed and the best herbivore animals got adapted to lands as high as the South American camelids are (the llama and the alpaca). Besides the guinea pig or cuye and a high

number of birds, especially ducks experienced the same situation. In this way, like the Yak has been tamed in the Himalayas.

The handling of the diversity can become extensive to the animals and can also be applied to the conservation of the suri and huacaya alpaca types, with different fleece colors and use. Also the llama could be tamed with specific objectives of meat, fiber or both production. In the same way this could happen with the wild species (species in extinction danger due to the illegal hunt, to the smuggling of species).

LOCAL KNOWLEDGE AND AVAILABLE CURRENT TECHNOLOGY

Many research works insist on pointing out that it is not possible to have sustainable development of the mountain ecosystems we do not the necessary attention to the local knowledge regarding the environmental administration. This has also been demonstrated by numerous experiences in The Andes (PRATEC 1986) the Himalayas, ICIMOD, 1990 as well as in the mountains of Ethiopia.

However, it cannot be ignored that the traditional technology obeyed certain circumstances and historical moments. Consequently, in our times it is no longer feasible either appropriate to apply some of these practices, just as they were near five centuries ago.

In other words, the appropriate proposal is to recognize that, for example, a terrace or platform is the technique for soil conservation and the most appropriate creation of new agricultural areas for the hillsides in The Andes. Those terraces, however, are not viable by themselves and should include a watering and efficient system, aspersion or drop watering; to use genetic material free of plagues and illnesses for thermal-chemical environments, or varieties free of virus reproduced by cropping fabrics in order to obtain a competitive yield.

The rural populations of The Andes are avid of adopting technologies that they could manage and make profitable. In the same way, immediately they adopted the yoke of oxen in the XVI century in The Andes together with the cropping techniques and strange upbringings, the machines that facilitate the thrashes and other technologies. Now they are willing to enter to the modern era, if it allows them to it to take care of their land properly and to reduce their risks.

FACTORS THAT AFFECT THE CONSERVATION OF THE BIOLOGICAL DIVERSITY

The Climate Factor

A characteristic of the mountain ecosystems is that they present a very varied on climate among years, being able to find, years of drought and others with floods. These climatic processes have facilitated the evolution of plants that had to adapt to these conditions. In the cases of pressure on the use of the land, could be hopeless losses of the genetic resources.

In the last years the climatic alteration is being more intense in planet. The phenomenon called "El Niño" is also affecting diverse ecosystems of mountains. When it takes place, rains exceptionally abundant and the rivers that come from The Andes over flow the lowest areas and harm the atmosphere and their inhabitants. The effect of this phenomenon is very varied and in the past they have caused processes of intense drought in turn in the ecosystems of the latitude 14° south and

excesses of rains in the north area. In the specific case of the cultivation of the potato, these climatic occurrences have produced the loss of important genetic material.

The Demographic Pressure

The pressure that a population produce has grown in the last years beyond 2,1% annually and has caused two effects: in the first place, it has incorporated in the agricultural soils marginal conditions that produce very poor crops that are getting lost and become less tolerant varieties to this soils. And, the most important thing, the process of erosion of the soils has been increased. Parallel to this, the highest demand for food has caused the mountain countries to increase the importation of food and to displaced the native ones, what leads to a process of erosion of the genetic resources.

An example of this has happened with the wheat importation that has been one of the factors that diminishes the quinoa and amaranth in The Andes, the Tef in Ethiopia and the height rice and the native barley in the Himalayas.

Contamination

The presence, every time bigger, of mining centers and the increment of mining residues is causing a high contamination level, a dramatic phenomenon that many countries of our region live and that it is responsible also for the loss of the natural vegetation. The smoke of the mineral processing plants that contaminate the area of La Oroya in Peru, and that cause the loss of vegetation in a coarse region of The Central Andes, this is only one of so many cases that can be in The Andes.

Diversity of Ecosystems

The mountain ecosystems - like The Andes - constitute spaces where you can find an array of microhabitats (microclimates, diversity of soils...) in which good conditions are given for the bloom of a great diversity of species and genetic variability.

Food Diversity as Expression of All the Diversities

An expression of this much diversity is the great food wealth that we can find in The Central Andes, arisen of the integration of the ecological (ecosystems) and cultural diversity.

Political and Legislative Frames

At the international level, we have the Agreement on Biological Diversity, negotiated since 1988 and signed by more than 150 countries during the United Nations' Conference on environment and Development that took place in River of Janeiro on 1992. Ratified by Peru by means of the Legislative Resolution N° 26181 of May 11, 1993.

CONSERVATION EX SITU, IN SITU

Related to the conservation of the biodiversity there are two big strategies: the conservation ex situ and the one denominated in situ.

The conservation ex situ, as its name indicates, implies a conservation outside of the natural habitat of the species that interests to protect. For it has been developed in botanical gardens, herbaria and germplasm banks among others.

The conservation in situ is related to the use and protection of the biological species - vegetables, for example - in its natural environment (forests, heaths, prairies) and also to those cultivated in the parcels by the farmers called 'preservers'.

Both ways of conservation are necessary and not excluding. In The Andes, the most developed one is the first one (INIAP, IBTA, CIP, INIA, diverse ONG). However, the farmers in The Andes and in the regions of the Pacific's coast and the Amazonian highlands have 8,000 years performing the use and conservation of seeds of the main cultivated species. With this, they have demonstrated the great preservers' tradition of one of the places that was center of origin of the agriculture in the world: The Andes.

5. THE ECOSYSTEMS OF MOUNTAINS IN THE WORLD

The presence of a high biodiversity in the mountains' ecosystems is repeated in the entire world. Among the population of the mountains in Central and South America, the Himalayas in the Asian continent, the mountains of Ethiopia, Kenya and Tanzania in Africa a diversity of crops is used. And associations of them allow them to manage the means more appropriately and to reduce the risk of the climatic conditions characteristics of those regions.

The wild relatives of these species are distributed around the mountains and their value resides in the fact that they are the genetic basis for the selection of new species. In this sense, the national parks perform an important role maintaining these resources and stopping the erosive process, a product of the over use of the vegetation, of soil burning and the inappropriate handling where hillsides with pronounced slopes become agricultural areas without a good soil conservation practice.

Most of the mountains' agricultural systems embrace the valley bottoms, pronounced slope hillsides and the high lands (plateaus), for it the farmers have had to develop strategies that allow them to use these different physical areas integrally to get the necessary resources. When losing the possibility to access to different ecosystems, they have largely lost their possibilities of a sustainable development and mainly of their food security.

THE MOUNTAIN ECOSYSTEMS

The agroecological classification for areas regarding their different characteristics is a fundamental approach to define the necessities and potentialities of a region or sub-region.

For The Andes conditions in the mountains of Peru it has been proposed a classification that considers three different hierarchical levels:

- Macro Level: the defined units as sub-regions.
- Mid level: agroecological areas.
- Micro Level: the smallest units as of homogeneous atmospheres for production.

This agroecological area determination would allow not to define the potentials of production in a more approximate way, but only to optimize the available resources for the development and to extrapolate in appropriate ways the results toward other comparable areas (Tapia 1996).

This classification largely recovers the local ethno-ecological knowledge and is based on the initial proposal that made by the geographer Javier Pulgar Vidal (1946) for the conditions in Peru.

Also, it presents a hierarchically stratified structure and has been adopted as proposal for the planning of rural development adapted to the conditions of agricultural use in The Andes of Peru that on the whole constitute an area of 39 million hectares, approximately a third of the whole national territory.

It is necessary to remember that the geography of Peru is strongly influenced by the presence of the Mountain range of The Andes that crosses the national territory from north till south and that transforms it into a country with mountains' predominance. The mountains' lands are those above the 1,500 and/or 2,000m. o. s., depending on the latitude and exposition.

In Peru, The Andes are located in tropical latitude and they have a strong influence of the Pacific Ocean in their western slope and of the Amazon in the oriental slope. They present very varied ecological conditions, from high deserts to mid-thermal valleys and to high rainfall areas with the rising adaptation of a varied vegetation and fauna.

At the moment, these territories are inhabit by more than seven million people essentially dedicated to agriculture and cattle raising and organized in small and medium individual proprietors' units. Cooperative organizations in more than five thousand traditional rural communities that comprise as much individual properties as communal lands in the center and south, and villages and towns in the north mountain.

Most of the population of this region are descends of old cultures and has conserved important knowledge on the handling of the natural resources. They adapted the soil resource by constructing terraces, ridges and "cochas" (artificial small squares, used to conserve the water resources by transferring humidity from a basin to other, construction of channels, watering high altitude grasses, bofedales and other modifications of the atmosphere guided towards a sustainable development.

Today, diverse social and economic factors as the increment the demographic pressure, liberation of the market, conflicts and abandonment of the field, are affecting the stability of these ecosystems seriously. From there, the urgent necessity to make decisions for their conservation and appropriate use before the erosive processes of the natural resources of this region determines their definitive loss.

THE ECOLOGICAL DIVERSITY

As it has been demonstrated in multiple studies (Troll 1952; Weberbauer 1945; Pulgar Vidal 1946; Brack 1986 and Tapia 1996), the mountain soils are not homogeneous. This

is shown in the existence of so different environmental conditions in the meso-thermal valleys, between the 2000 and 3500 m. until the height areas at 4,300 m. with frigid climates characteristic of other latitudes.

According to the 'agroecologic zonification' proposal for the Andean ecosystems the mountains in Peru (Tapia 1996), six sub-regions can differ:

I. The Western slope's Andes.
II. The Northern Andes.
III. The Central Andes.
IV. The South Central Andes.
V. Lake Titiaca highlands (Altiplano).
VI. The Oriental slope's Andes.

In these sub-regions is possible to differentiate eighteen agroecologic areas, according to the diverse combination of factors like altitude and climate, closely related to the use of the land:

- The areas of the bottom of mountains denominated "yunga". In Peru the marine yunga differs between the western slope and the fluvial yunga that it is directed towards the Amazon.
- In the bottom of the inter-Andean valleys is the "Quechua" area, appropriate for the cultivation of corn, differing between semi-humid and the most arid areas.
- The Andean hillsides and plateaus or "suni" areas, rich in varieties of tubers and Andean grains differ according to the sub-region.
- The highest areas or top of mountains. In the north they are denominated "jalca", in the center and south are called "punas" (differing between "arid punas" and "semi humid punas") are appropriate for pastures for the upbringing of camelids.
- In the south sub-region is the highest area called "janca" or "cordillera" at 4,300m. o. s. (Map).

At the interior of each agroecologic area, in turn, we can differentiate homogeneous production areas where the differences are determined by the edafic characteristics and the human activity that can modify the production conditions. The margin of variability in the production and agricultural productivity will depend on the modifications applied technologies.

This differentiation of agroclimatic and edafic areas is mentioned with emphasis because their fragility is not similar, neither the same are the factors that affect and determine the biological diversity and its potential erosion.

The geographical isolation due to the presence of mountains favors a high endemic index and a genetic diversity that it deserves to be more studied, investigated and used.

Our old inhabitants recognized this biodiversity and made use of it originating - in matter The Central Andes - a great taming nucleus not only for vegetable species (potato, corn, cotton, beans, tomato and quinoa among other) but also for animals (guinea pigs, llamas, alpacas, vicuñas and ducks).

At the moment this conservation and maintenance process of the genetic resources continues in charge of the most traditional farmers whom, in spite of all the setbacks, still conserve in their "chacras" (parcels) the tamed and in some cases wild vegetable species (I process called conservation now in situ). They show their concern for the maintenance and use of the traditional varieties and, in the case of The Andes, they avoid the genetic erosion of the traditional and wild potatoes.

Some scientists have called the mountain ecosystems "the towers of water" because they give this vital element to all the cities, inclusive to those of the lowest areas. Well taken advantage of, the water resource constitutes the most important component in the natural resources and become energy mobilizing great percentage of the industry.

It is necessary to mention, although shortly, the existent relationship between the biodiversity and the conservation of the hydrological potential of the mountain atmospheres. With a good vegetable covering a good reception of humidity is achieved, and simultaneously allows the existence of important sources of water of high quality.

THE ANDES

With their 7,250 K long, The Andes constitute one of the most inhabited mountainous systems in the world, with approximately thirty million people that live above the 1,000 m. o. s., and an occupation that began more than ten thousand years ago (see chart).

Dollfus O. (1981) recognizes for the Andean system two types of Andes: The Equatorial Andes, lower and clipped, with permanent clouds most of the year, to which it denominates The Green Andes and The Tropical Andes where dominate the reddish and yellow tones, are called The Brown Andes. There the plateaus and highlands occupy half of the surface and are enhanced by the big snowy mountain ranges. Also, a marked and contrasting dry period exists (June-November) and a humid one (December-March). Between the two slopes, one is extremely rainy, the oriental (>3000 mm/year) and the other is extremely arid, the West (<200 mm/year) generating water asymmetry as it has been called. The Andean system is the great computer of the ecology of Peru.

For about 7,000 years the climate of the Andean system has not presented wide variations and its vegetation has been very similar for about 7,500 years (Dollfus 1981).
THE MOUNTAIN RANGE OF THE ANDES: THE GREAT ORDERER

The Mountain range of The Andes constitutes a fundamental element to understand the ecology of South America and Peru as well as the diversity that is one of the most important features in our landscapes. Besides the presence of the Mountain range other conditions exist - like the proximity to the equatorial line (tropical area) - that explains this diversity.

The Andes determines the course and the form of the rivers and also the distribution of the rains in our country and in South America. But also, like it is common in all the mountains, they make very different spaces with strong physical and biological contrasts between small areas very next to each other (in the western slope rains less than 200 mm/year and in the oriental slope rains more than 3,000 mm/year).

The Mountain range, particularly in their oriental hillsides, appears as well as an enormous genetic bank bearer of a great biological diversity.

In general, the specialists point out that at Peru's level should exist between 17 and 50 thousand species of tamed plants (cultivated), which are important not only for the Peruvians but also for all humanity. Near 1,200 wild species are useful plants - medicinal, textile, nutritious and industrial uses among other - (CNUMAD 1992, GTZ-INRENA-FANPE 1996).

This great diversity of landscapes and life forms in an unstable environment, especially in the climatic aspect, makes this Mountain range to be considered among the fragile ecosystems. These ecosystems should be used with much care, as it has been done by an array human groups that have inhabited these beautiful and complex places for almost 10,000 years.

If we see Peru through traverse cuts, we will appreciate the crucial paper of the Mountain range. And, it is in this context that the coast and the rain forest are two areas that depend - as for water, floors, minerals, foods, water energy and other elements - of the high areas of these young mountains. The Andes appear, as it can be seen in Figure 3, as an arch that integrates the coast and the rain forest. Therefore, the mountain has a big responsibility in the continuity of the coastal and amazon subsystems that are at both sides of the Mountain range and of the megadiversity that each one harbors.

Finally, it is necessary to point out that the fact of enhancing the paper of the Mountain range does not mean ignoring the one played by the other four factors that intervene in the conformation of the Peruvian environment, these are:

1) The Peruvian Oceanic Current Average
2) The Anti-cyclonic Cell of the South Pacific (an area of high atmospheric pressure).
3) The Equatorial Current or El Niño.
4) The Equatorial Cyclonal Cell (an area of low atmospheric pressure).

THE ANDES OF PERU: "SIERRA"

At world level, Peru is a country that is characterized by its high biodiversity, characteristic of its three well differentiated regions: the coast almost dry, a continuous mountain system that crosses the country from north to south and a tropical forest. Neither is uniform.

This part of the text will talk about the situation, the potential and the advantages that would have the appropriate use of the biodiversity under the conditions of the Andean mountains (that constitute 30% of the national territory in Peru).

In order to know the relevance of the mountains ecosystems, comes to the case to remember that more than 20% of the terrestrial surface it is considered as mountain ecosystems and in them the 10% of the world population lives.

The inhabitants of these ecosystems, mainly in the tropical latitudes, they are devoted mostly to the agricultural production and conform, at the same time, the groups where there is more poverty. For example, in Centro America's mountains, the Caribbean and The Andes live between 30 and 50 million people whose main activity is the agriculture and they show the lowest levels of life. These obtain at least half of their foods from these ecosystems.

It is accepted worldwide that the mountains' atmospheres present enormous challenges to the planners when it is time to institutionalize in rational form the programs for an agricultural development.

Among the environmental conditions of these areas that may differentiate them of other regions we can mention:
1) inaccessibility,
2) heterogeneity,

3) fragility,
4) marginality,
5) the varied mechanisms that their populations have developed for their adaptation (Carson 1990; Jodha et al., 1992).

These characteristics are not similar for all the countries with mountain conditions. Due to the human pressure exercised on these atmospheres and given its condition of fragility, the developing countries are facing a quick degradation and loss of the basic resources for production. Meanwhile, in developed countries these ecosystems are broadly protected and in some cases with important policies of subsidies, like it happens in the European Alps.

In turn, in the scientific, productive and economic spheres every day is recognized more and with bigger evidences that biodiversity is fundamental for the agricultural production and alimentary security. However, the conflicts between the objectives of a highly productive agriculture and the biodiversity are unavoidable.

Certain patterns of very intensive agriculture that use external inputs, have deteriorated the biodiversity in the agriculture ecosystems, including the soil genetic resources of plants, animals, insects and organisms. Nevertheless, with the application of practical ecology towards a sustainable agriculture and with changes in the politic and agricultural institutions this problem can be overcome (Thrupp 1997).

In this sense, the conservation and protection of the wild flora and fauna in the mountain areas are immense and obligatory tasks to that we should add with priority to their inventory and study.

The flower inventories, in particular in protected areas, have a special meaning for those who work in botany as much as for those that are more related with the handling strategies and conservation (Young and León 1990).

In other times, the mountain ecosystems were a center of biophysical and cultural development, with an appropriate use and attention in the conservation of the natural resources as the climate, soil, flora, fauna and the taming process of numerous plants. It allowed the generation in The Central Andes, of power stations of endogenous agriculture that contributed to the world with important crops.

This way, because, they are the high lands of Mexico, Central America and The Andes those that have contributed substantially to the world feeding with the taming of corn, potato and at least other thirty crops of importance.

Biodiversity, of course, is a concept that includes the ecosystems and the usable natural resources, as much as the culture and knowledge that exists of its handling and use.

The administration of the Andean biodiversity should not exclude the knowledge of the means, its resources and the population with its technology and experience accumulated in hundred of years of test and error, combining everything with the application of technologies that our civilization has known to develop.

Referring to The Andes in Peru is to speak of the mountain and a space of 39.2 million hectares that constitute between the 28 and 30% of the national territory, with a longitude of approximately 1,800 km and height limits among 1500 – 2000 meters (inferior limit) and 5,000 meters. There are settled 8.52 million inhabitants, that is to say, the Peruvian population's 35,5%.

If we had to summarize the most important features in the ecosystems of high Peruvian mountain – "mountain" - we would point out the climatic uncertainty, the biological diversity, the physical geographical heterogeneity and, as consequence, the fragility.

To begin with the physical factors, due to the tropical location of The Peruvians Andes, the climate is marked in its annual rhythms by the precipitation seasons than for the differences in the seasonal temperature averages. Being distinguished clearly a rain period (3-4 months) and a dry period (9-8 months).

On the other hand, their location at west of a continent, near the Pacific Ocean (the vast in the world) and the importance of their mountainous mass that modifies the circulation of the air masses generated by the big subtropical anticyclone cells (Dollfus 1991), creates a climatic atmosphere of great uncertainty.

The precipitation can oscillate between 200 and more than 1,000 mm producing droughts or floods. Also, the registered temperatures fall abruptly below zero and create frost conditions. These are some features of what several authors have called the "climatic uncertainty". It makes agriculture - that is fundamental on land without irrigation in this area - become an activity of high risk, mainly for the conventional agriculture.

As for the soil component for these ecosystems, it is necessary to highlight the following features: they are generally thin and exposed to intense erosion processes for the pronounced slopes in those that are. These are very heterogeneous soils that are related with the climatic, physiographic and biological diversities of the region. A form of ordering this diversity is classifying it in agree with the physiographic conditions that have developed; in this way we have hillside, interandean valleys and plateaus' soils.

For the above mentioned would be necessary to add that in accordance with the highest use capacity for these soils, the mountain only possesses only 3.42% with vocation for clean crops, while 27% is pastures and 64.21% is protected areas. On the other side, if consider that of the 39.1 million hectares, 1.51 are currently used for agricultural purposes when the potential use is of 1.36 millions, we can conclude that have overdrawn this item in approximately 156,000 hectares.

What is what happens? Undoubtedly, we have a methodological problem when classifying the soils that it is necessary to review. Because many areas that do not have a given agricultural potential due to their strong slopes, thin soils, lack of vegetable covering, exhibition to frost precipitation, are used for the agriculture in such a way that a technology has been developed for those conditions.

Finally, it is necessary to highlight the next: in spite of their uneven topography, the mountains are the biggest area with soils of high natural fertility in the country, and concentrates 60% of the agricultural area of Peru (Tapia 1996).

6. WORK SUGGESTED

Being very close the celebration of the year 2002 as the world's year of mountains, it seems very appropriate to make suggestions that would allow us to assure the conservation, use and mainly revaluation of these ecosystems, in a program of medium long term.

REVALUATION OF THE ECOSYSTEMS AND THE NATIVE CROPS

Once characterized the mountain areas, it is necessary to analyze the factors that have produced their backwardness or marginal situation. In this respect it would be necessary to mention that the products of the diversity of these mountains have not been considered as resources with economic potential. And the history is full with these cases.

No more than four centuries ago the potatoes and corns did not have the value that they have nowadays. Their investigation, development and wide use in the developed countries have made them to constituted nutritious resources of first order. Now it can be the time the maca, quinoa, kiwicha and arracacha among others.

Some of these crops come from being food from complex and very varied agricultural systems to be single crop of extensive areas with a high technological intensity, that has allowed to obtain very superior yields opposing the ones in their origin place making them very competitive. However, the obtaining of these results has cost an ecological investment of a high energy level, of inputs that many times are not profitable.

Other crops associated to these did not have the same luck. So far, the tubers that accompanied the potato, for example, are less considered or the grains associated to the corn - like the quinoa - are just conquering markets outside the Andean region.

The alimentary education as strategy for the revaluation of the native crops seems to be one of the more sure ways so that such resources - that conform the few comparative advantages that have the mountains - do not get lost hopelessly.

SUPPORT IN THE CONSERVATION IN SITU

The first reaction to the loss of the genetic resources of the native crops of the mountains, was to preserve them for the future generations in germplasm banks of conditions of low humidity and controlled temperatures that maintain their latent life.

Several experiences show that this methodology does not only stop the natural process of evolution of the species, but leads to rather enormous material losses since they need to be renovated often.

The alternative has been then to preserve and to maintain these resources in the farmers' parcels, supporting the normal processes of exchange and refreshment of material that is in continuous interaction process with its environment.

This process - inappropriately called conservation in situ, because it is not the conservation what is pursued but preserving a dynamic process - has been denominated the upbringing of the crops and accompanies the work that the farmers have carried out for generations (PRATEC 1996).

An experience in this sense is carried out specifically with the Andean tubers at the International Potato Center (RTA 1997) and more thoroughly with the work of several ONGs than they are proving different methodologies.

Since 1990, the Consortium for the Sustainable Development of the Andean Eco-Region (CONDESAN) and the Asociación for Cajamarca Rural Development (ASPADERUC), with the support of the FAO office, have been perfoming one of these

conservation in situ experiences in the area of The Encañada-Namora-Sorochuco in Cajamarca, at the north mountains of Peru (ASPADERUC 1995).

EXCHANGE OF GENETIC RESOURCES AMONG ECOSYSTEMS OF MOUNTAINS

The advantages that would have an exchange of genetic material among areas of mainly tropical mountains as those of the Himalayas, Africa of the Northeast and The Andes was discussed in the meeting on mountain agriculture and genetic resources held in 1978 at Katmandu - Nepal (organized by the International Center for the Development of the Mountains in the Himalayas - ICIMOD).

This exchange has begun already several centuries ago, for what is not difficult to observe important potato fields and more recently of quinoa and amaranth in the terraces of countries like Nepal.

CHANGES IN THE NATIONAL POLITICIES RELATED TO THE BIODIVERSITY

The fundamental action to protect the biodiversity under the mountain conditions is related to the policy that a country assumes to maintain and use it. This includes the policy for the import of foods, the handling of the genetic resources, the research and mainly, the conservation of the ecosystems, but from an integral perspective and not as isolated actions.

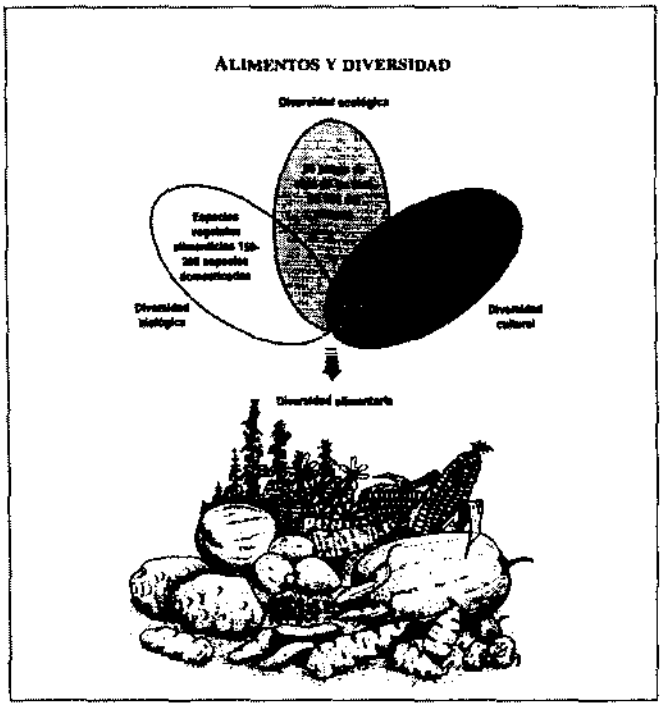

Figure 3. Food and Diversity

The educational process completes in this sense a fundamental work. A country with high ecological diversity and biodiversity should support an education that foments that each one of its inhabitants becomes a defender of the biodiversity and that propose not only to keep it but to use it in the adequate way.

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Footnotes
2. WRI, UICN, PNUMA 1992.
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