CEPAL
Review

UNITED NATIONS
ECONOMIC COMMISSION FOR LATIN AMERICA

SANTIAGO, CHILE / APRIL 1983

CEPAL

Review

Number 19 | Santiago, Chile | April, 1983

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CEPAL REVIEW
April 1983

The Andean peasant, water and the role of the State

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The Andean regions of Latin America encompass a vast mountainous zone of alternating high peaks, hillsides and relatively narrow valleys; rivers and ravines form a large number of basins in this area inhabited by scattered population groups which exert heavy pressure on the fragile renewable resources to be found there.

In order to live in this environment, the inhabitants of the Andes must have the organization and know-how necessary not only to meet their own food production needs through proper management of natural resources –mainly water and the soil– but also to promote the conservation of those resources.

In the opinion of the authors, history demonstrates that the pre-hispanic inhabitants considered three elements as being essential for proper management of the basins in general and of water in particular: (a) the organization and co-ordinated participation of the community in the work; (b) the use of technologies and working methods adapted to the zone; and (c) control over a sufficiently large vertical and horizontal area to allow various ecological levels to be managed simultaneously.

At present there are still only a few government-sponsored programmes and projects in Latin America which take the above considerations into account and devote their efforts to providing technical assistance to the peasants for integral management of basins or hillsides on the basis of appropriate technologies. The study emphasizes, however, that the programmes in operation which cover these aspects, although few in number, indicate that there is a vast potential for the exchange of know-how through appropriate horizontal co-operation machinery. Such co-operation would primarily take place among the countries of the Andean region, but could be expanded to include all of the region's mountainous areas, thus benefiting the rural population of mountainous areas throughout Latin America.

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Introduction

Water in the upper Andes is a relatively scarce, and therefore very valuable, resource; it is of crucial importance to the well-being of the region's inhabitants, since theirs is a primarily agricultural economy.

For that reason, the pre-Columbian Andean culture developed complex techniques for developing this resource which allowed the people to preserve the catchment areas (i.e., basins and hillsides), to manage the water through water works and by changing the gradient of the slopes, and to protect themselves from risks during times of excessive rainfall.[1]

Although the Spanish colonists did not neglect agriculture entirely, they did permit the catchment basins and the works designed for water use and control to deteriorate.[2] The advent of the republics (independence) did not improve the situation which arose under the colonists,[3] and water ceased to be a reasonably reliable factor of well-being for Andean peasant communities.

The objective of this study is to describe the present situation of the Andean inhabitants, and particularly the peasants, *vis-à-vis* Andean hydrological dynamics, as well as to propose means of improving these people's relationship with their environment, using water management as a frame of reference. Because of their particular characteristics, Andean hydrological dynamics call for a special form of management which takes into consideration the well-being of the Andean inhabitant in terms of his organizational capacity, real needs, cultural values and technical know-how as regards environmental management.

The nature of water dynamics in the Andean environment, taking into account both the geo-physiographic environment

[1] S. Antúnez de Mayolo, "La predicción del clima en el Perú precolombino", in *Interciencia*, Vol. 6, No. 4, July-August 1981, p. 206.

[2] H. Villanueva and J. Sherbondy, *Cuzco: Aguas y poder*, Cuzco, Centro de Estudios Rurales Andinos Bartolomé de las Casas, December 1978.

[3] Oliver Dollfus, *El reto del espacio andino*, Lima, Instituto de Estudios Peruanos, February 1981.

—particularly river basins— and the hydrological phenomena peculiar to the Andes, are dealt with below. A description then follows of the way in which utilization of the natural resources of the basins has evolved and how it has deteriorated from pre-colonial times until today. An assessment is then given of the various programmes, projects and activities currently being carried out in order to prevent further degradation of the high mountain basins and its resultant effects on the water and the inhabitants. Finally, some broad conclusions are drawn based on the preceding analysis.

This study attempts to demonstrate the historical and technological importance of participation by the inhabitants and users of the basins in the management of the natural resources they contain, as well as to point out the responsibility which should now be assumed by the State in facilitating and promoting such participation. It also explains that, as history has demonstrated, various ecological levels must be managed simultaneously in the high Andean region if efforts are to be successful. Finally, it emphasizes the need to retrieve, adapt, develop and disseminate technologies appropriate to the area, and to that end, recommends the promotion of horizontal co-operation among countries and specialized institutions. The progress which has been made through the creation of Latin American co-operation networks for these purposes and the need to encourage their operation are also underscored.

I
Water dinamics in the Andean environment

1. *The configuration of the Andes*

The Andean cordillera has distinct characteristics depending upon the latitude concerned. In Ecuador and Peru, it is 150-250 km wide and towards the north has a series of mid-elevation basins flanked on the east and west by formations more than 5 000 metres in height, whereas towards the south the basins are generally dry and bisected, and already show a difference between the dry western side and the humid Amazon face.

In southern Peru and northern Bolivia the cordillera is much bigger, attaining its greatest width, of approximately 500 km, in Bolivia. High plateaux extend over most of its width and are circled by peaks with heights of more than 6 000 metres above sea level.[4]

2. *The Andean hydrographic basins*

The particular configuration of the Andean chain gives rise to the formation of hundreds of hydrographic basins displaying a wide variety of hydrological features, according to the direction of flow of the rivers, their latitude, altitude above sea level and the slope on which they are located.

In the valleys and on the slopes formed by these basins are large population centres whose main activities are agriculture, stock raising and mining. To a large extent they are dependent upon climatic conditions for their survival, particularly upon the availability of water.

The most important valleys and human settlements from a geo-socioeconomic standpoint are between 1 500 and 3 600 metres above sea level. Many towns are located at the headwaters of the basins, where there is a shortage of water during certain times of the year due to a lack of adequate catchment areas and dam sites.

The most heavily populated upper basins usually have a longitudinal orientation parallel to the major branches of the Andean cordillera, as in the case of the Mantaro, Santa and Cajamarca river basins in Peru. In their upland regions, they contain suitable

[4] Oliver Dollfus, *ibid.*

water storage areas in the form of glaciers, snowfields and numerous lakes, mostly located at altitudes of over 4 000 metres above sea level.[5] The management and control of these lakes for the regulation, protection and supply of water is an important and familiar activity in the Andean zone.

When suitable dam sites are lacking, all that can be done is to retard the flow of surface water as much as possible, using agricultural, forestry and pasturage methods of basin management and small collection structures for sub-surface flows. This activity is unfortunately not widespread today.

3. *Elements of Andean hydrological dynamics*

The geography of the Andes, because it includes a variety of altitudes, latitudes and directional trends, is conducive to the presence of water in all its forms.

(a) *Precipitation* (table 1) occurs mainly as rainfall from northern South America to central Peru, at which point precipitation in the form of snow increases in the highlands. In Peru and Bolivia,[6] rainfall in the inter-Andean basins ranges from 300 to 1 100 mm, which allows annual and perennial crops to be grown. In these countries, 80% of the annual precipitation occurs between December and March, with the remaining 20% distributed over the rest of the year. The driest month is July. In the Andean zone of Ecuador, the rainiest months are from March to May. Rainfall is slightly greater than in Peru and Bolivia and has a more uniform distribution both along the Pacific and the Atlantic slopes, with 1 000 mm isohyets on both flanks of the cordillera.[7] At altitudes over 1 800 metres above sea level in the Cordilleras Occidental, Central and Oriental and the Sierras de Santa Marta in Colombia, there is a tropical mountain climate with a better distribution of precipitation throughout the year than in Peru and Bolivia, there being two periods of maximum rainfall from May to June and from October to November, and two minimum periods from December to March and from July to September. The driest season is from December to March. Precipitation in upland areas fluctuates around 1 000 mm per year, as in Bogotá (2 560 metres above sea level and approximately 985 mm of rain yearly).[8]

(b) *Watercourses.* The rivers and streams in the upper Andes are fed from the melting snow and precipitation on the altiplanos ('punas', or wide barren plains). In the relatively flat highlands, the rivers form meanders and lakes, and then pour down narrow ravines or canyons, depending upon the volume of water and the size of the basin, until they reach lower levels and flow into relatively flatter areas.

In areas with these characteristics, the régimes of the rivers vary with the precipitation and thaws. The rivers on the Pacific slope in northern Chile and in central and southern Peru are torrential and seasonal; their discharge may range, as in the River Cañete in Peru, for example, from a few m^3/s to 800 m^3/s in basins measuring 5 000 km^2.

In the intermediate stretches of these rivers, between 2 500 and 3 000 metres above sea level, crops are grown almost exclusively with irrigation since rainfall is less than 500 mm and is concentrated in the months of January, February and March. The rivers which supply water for irrigation usually have to be regulated. This characteristic is common from the north of Chile to northern Peru. In contrast, the basins of the

[5] Medardo Molina and Eduardo Seminario, *Estudio hidrológico de la cuenca del río Santa*, Lima, Instituto Geofísico del Perú, 1975.

[6] Instituto Nacional de Preinversión, *Información necesaria en Bolivia para planificar, ejecutar y administrar la utilización de los recursos naturales, principalmente hídricos*, La Paz, 1979.

[7] INAMHI–Ecuador, *Anuario meteorológico 1979*, Quito, 1981.

[8] United Nations, ECLA, *The water resources of Latin America, III. Bolivia and Colombia*, New York, 1964.

Table 1

ANDEAN COUNTRIES: MEAN PRECIPITATION, BY MAJOR BASINS

Country	Cuencas							
	Caribbean		Pacific		Amazon		Titicaca	
	Area (km^2)	Mean precipitation (mm)	Area (km^2)	Mean precipitation (mm)	Area (km^2)	Mean precipitation (mm)	Area (km^2)	Mean precipitation (mm)
Venezuela	191	1 330	–	–	43	3 320	–	–
Colombia	116	2 690	78	4 970	330	2 840	–	–
Ecuador	–	–	134	1 640	150	2 310	–	–
Peru	–	–	279	200	956	2 180	57	720
Bolivia	–	–	–	–	718	1 380	149	220
Chile	–	–	757	1 030	–	–	–	–

Source: ECLA, on the basis of the country reports for the United Nations Water Conference and other publications (1977).

Atlantic slope generally have a permanent albeit irregular régime. In Peru, the floods begin in October and end in March, reaching their high point in January and February and their low in July or August.[9]

As could be expected, the discharges fluctuate with the variations in rainfall. Thus, in Bolivia and Peru the peak floods occur in February and March (the rainy season), while the water is at its lowest level from May to September. In Ecuador, however, "the seasonal distribution of the minimum flows is more complex: in some central zones of the inter-Andean corridor (the Riobamba, Ambato, Latacunga and Quito areas) some rivers have their lowest flows in July, August and September, while in other sectors, which may be very close by, where the régime is related to easterly air masses, the minimum flows are in December".[10]

In Colombia the régimes are also very closely related to the rainfall on the three slopes (Pacific, Atlantic and Caribbean). As with the rainfall, there are two maximum and two minimum flow periods in most of the rivers. In the Cauca area, the peak discharges occur in May and November, and the lows in February and September. This varies slightly in other major basins, such as that of the River Magdalena.[11]

(c) *The Andean lakes.* In the Andean high plateaux, or 'punas', there are a great number of lakes which serve to regulate surface water. Tables 2 and 3 provide information on the lakes of Ecuador and Peru, respectively.[12]

(d) *Groundwater.* Groundwater is a very important source of water for human consumption and irrigation during periods of low water levels; on the hillsides of the inter-Andean valleys it forms what are known in Peru as 'puquiales' or 'manantiales' (springs). The flow of a spring can range from a few litres up to several cubic metres per second, primarily depending upon its location. The springs in the lower valleys have a greater flow because they are also fed by the irrigation water from the terraces. However, a spring is most highly valued for its flow during the low-water period, when that discharge is less because it coincides

[9] National Office of Natural Resource Evaluation, *Inventario y evaluación nacional de aguas superficiales*, Lima, 1980.

[10] PRONAREG, *Elementos básicos para la planificación de los recursos hídricos en el Ecuador*, Quito, 1981.

[11] United Nations, ECLA, *The water resources of Latin America, III.*, *op. cit.*

[12] UNESCO, Second Meeting of Subregional Co-ordinators for the Preparation of the Hydrological Map of South America, Quito, Ecuador, 21-24 July 1981.

Table 2

ECUADOR: SUMMARY OF LAKES AND LAGOONS

Water surface (km^2)	Number of lakes	Recharge area (km^2)
Less than 1.0	172	0.10 – 203.8
1.0 – 5.0	17	
5.0 – 10.0	6	
Greater than 10.0	2	
Total	197	

Source: INERHI, "Recursos hidrológicos superficiales del Ecuador, Primera Evaluación", *op. cit.*

Table 3

PERU: SUMMARY OF LAKES AND LAGOONS

Slopes	Lakes under exploitation		Lakes under study		Additional capacity in existing dams		Lakes with basins	
	Total number	Regulation capacity (millions of m^3)	Total number	Regulation capacity (millions of m^3)	Total number	Regulation capacity (millions of m^3)	Greater than 4.0 km^2	Total inventoried
Pacific	105	1 378.6	204	616.6	34	98.8	336	3 896
Huarmicocha	3	41.0	1	185.0	1	144.0	4	23
Atlantic	76	1 604.4	133	3 006.4	9	836.6	461	7 441
Titicaca	2	4.1	4	145.0	--	--	65	841
Total	*186*	*3 028.1*	*342*	*3 953.1*		*1 079.4*	*866*	*12 201*

Source: ONERN, *Inventario nacional de lagunas y represamientos, segunda aproximación*, Lima, 1980.

Note: The lakes are sources of water for human consumption and irrigation in low-water periods.

with the reduced flow of the rivers in rainless periods. In general, the possibility of utilizing groundwater has not been studied very much in Latin America in connection with the high mountain regions, but efforts are now being made to make up for this lack of information.

In the high Andean regions, drainage problems are also common, especially in the highlands and 'pampas', such as in the Anta pampa in Cuzco, Peru.[13] The cross-section shown in figure 1 illustrates the various forms in which water appears along the slopes of an inter-Andean basin in Peru.

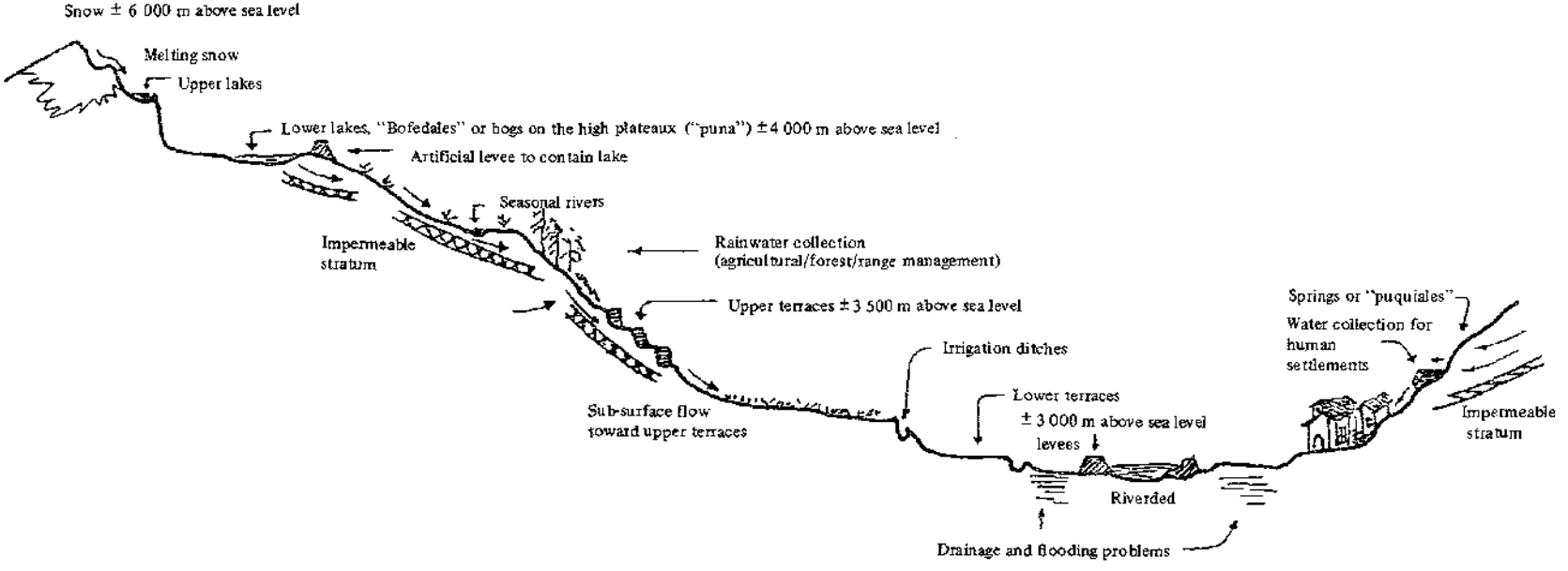
(e) *Evaporation.* Due to the different combinations of temperature, altitude, latitude and dryness of the atmosphere, evaporation in the Andean region is highly variable. Thus, in the altiplano region it is estimated at 1 660-2 110 mm per annum.[14] Evaporation in the Cuzco region has been found to vary from 780 mm in Anta (3 435 metres above sea level) to 1 500 mm in

[13] Ministry of Food and Agriculture of Peru, *Diagnóstico de la Cuenca Alta del Río Vilcanota*, Lima, 1979.

[14] ECLA-Ministry of Planning and Co-ordination, *Proyecto de prefactibilidad para el desarrollo del Altiplano*, La Paz, 1977.

Figure 1

FLOW AND USE OF SURFACE WATER AND GROUNDWATER ALONG THE SLOPE OF AN INTER-ANDEAN BASIN



Typical cross-section of an inter-Andean basin in the central zone of Peru with indication of average elevations above sea level.
ECLA/A. Dourojeanni and M. Molina, 1982.

Table 4

ECUADOR: EXAMPLES OF EVAPORATION AT VARIOUS SITES, 1979

Site	Altitude (metres above sea level)	Evaporation (mm)
El Angel	3 055	1 357
San Gabriel	2 860	692
Otavalo	2 556	916
Quito	2 818	904
Rumipampa	2 628	1 040
Pirayambo	3 615	650
El Labrado	3 260	732

Source: INAMHI, *Anuario meteorológico 1979*, Quito, 1981.

Calca (2 926 metres above sea level).[15] Observations made in Ecuador in 1979 are given in table 4.

(f) *Snowfall.* Starting at 4 500/5 000 metres above sea level, there are perpetual snows is the Andes chain which constitute reserves of water of excellent quality and are the source of springs and lakes. Statistical data on the volume of the water reserves in the form of snow are not available.

4. *Water quality*

All the water in the Andes is generally of good quality for irrigation. The springs can be used without treatment to supply the peasant population;[16] however a problem of river pollution from tailings does exist in basins where mining is taking place.

II
Historical development of water resource management in the high Andean region

History provides some useful lessons for planning the future and, as Sherbondy says, "...before all the agricultural land (of Cuzco) goes dry; before all the water is polluted, let us learn from the experiences of the past 500 years in order to formulate adequate solutions for the next 500 years".[17] The varied historical experience of land and water development in the high Andean region which is described below may contribute to the formulation of such solutions.

(a) *Pre-hispanic period.* The Andean inhabitant had two basic concerns regarding water management: (i) the management of surface run-off and (ii) the development and conservation of the hillsides. This management was part of an integral approach involving the need for vertical control of the various ecological levels, starting with the highest peaks.[18] The focus was therefore not

[15] Ministry of Food and Agriculture of Peru, *Diagnóstico de la cuenca alta del río Vilcanota, op. cit.*

[16] Medardo Molina, *EL agua en la comunidad de Aucará*, Lima, Universidad Nacional Agraria "La Molina", 1975.

[17] H. Villanueva and J. Sherbondy, *Cuzco: Aguas y poder, op. cit.*

[18] Stephen Brush, "Estrategias agrícolas tradicionales en las zonas montañosas de América Latina", Proceedings of the Seminario Internacional sobre Agricultura de Ladera

limited to water and land control, but was instead equivalent to modern concepts of basin management.[19] Nevertheless, it is evident that the control of at least these two resources was of paramount importance, as is attested to by the numerous water works and ancillary modifications noted in the Andean region. Three fundamental features of this stage should be retained:

(i) *Community participation* in the execution of projects, which not only made it possible to plan and execute projects, but also provided for the operation and maintenance of the facilities constructed and proper conservation of renewable natural resources in general.[20]

(ii) *Technological and scientific development* which permitted the rational management of different ecological levels and the development of advanced technologies[21] for water management and even weather prediction,[22] for the purpose of protecting the population from droughts or floods through the use of such varied options as the appropriate siting of towns, the processing and storage of agricultural products, and diversification of crops and genetic resources, as well as aspects directly linked to water management.

(iii) *The minimum land area, measured both horizontally and vertically*, necessary for them to control the various ecological levels and thus to manage the water as well as the various crops they relied on for their livelihood during the annual and inter-annual climatic periods.

(b) *Colonial era.* One of the effects of the presence of the Spaniards in Latin America was the disruption of the harmonious and integrated management of renewable natural resources.

At the outset, the prevailing communal system was altered by the introduction of coercive measures or by eliminating those people who, according to our present-day concepts, would be local resource conservation leaders. In other words, the groups which directed the management of natural resources, as well as the interdisciplinary groups which implemented the plans for their utilization, were destroyed. This, as Warman indicates,[23] was probably the result of "an understanding of the communal territory only in quantitative terms and in its horizontal dimension. For the conquistadores, property was a block of land, whereas for the indigenous population it was an aggregate of differentiated and complementary resources...". The aspect of the colonists' actions worth retaining is the care which they always took in operating the water systems which had been constructed, as is evidenced by various documents which illustrate the importance assigned to water distribution.

In one of those documents, "La repartición de las aguas del Cuzco de 1659", the authors say "...the importance of the 'Repartición' of 1659 is that it was a redistribution of water after a 54-year interval; during that time substantial changes had taken place in the zone's system of irrigation, cultivation and in the ownership of agricultural land itself, and these circumstances had created problems which required an immediate solution. This 'Repartición' was carried out by the famous Dominican, Friar Domingo de

en América Tropical, held in Turrialba, Costa Rica, 1-5 December 1980.

[19] The management of a basin, according to current concepts, is essentially an aggregate of administrative activities (in a business sense) which man plans and implements in order to develop and protect the natural resources contained in a geographic area which is demarcated on a hydrological basis. From A. Dourojeanni and L. Oberti, "Principios para elaborar un plan de protección de cuencas", *Boletín Técnico* No. 11 of the General Directorate of Water and Soil of the Ministry of Agriculture of Peru, Lima, 1979.

[20] Luis Millones, "Etnohistoriadores y etnohistoria andina: Una tarea difícil y una disciplina heterodoxa", in *Socialismo y participación*, Lima, June 1981, p. 77.

[21] I.S. Farrington, "Un entendimiento de sistemas de riego prehistóricos en el Perú", in *América indígena*, Vol. XL, No. 4, Mexico City, October-December 1980, p. 691.

[22] S. Antúnez de Mayolo, "La predicción del clima en el Perú precolombino", *op. cit.*

[23] Arturo Warman, "Tenencia y uso del suelo: Una visión histórica", Proceedings of the Seminario Internacional sobre Agricultura de Ladera en América Tropical, held in Turrialba, Costa Rica, 1-5 December 1980.

Cabrera Lartaun, *Juez Visitador General* for the indemnification of the Indians and the assessment, sale and disposition of the lands of the region by special command of the Viceroy of Lima, don Luis Enríquez de Guzmán, and it demanded no little effort of the intelligent and wise official, who acted with a true sense of equity and with an unwavering will to protect the Indians, as his primary mission was to make amends to them".[24]

The fact which this official unfortunately failed to realize (like many others today) is that no matter how well water is distributed, good intentions accomplish very little if the management and conservation of the basin from which this natural resource flows are neglected. Hence, although the Spaniards, of necessity, concerned themselves with water distribution, on the other hand, they forgot about where it came from. Thus the upper and lower sections of the slopes progressively diminished in importance as regulators of surface run-off and agricultural zones; they became over-exploited livestock and forest areas, resulting in the erosion and abandonment of existing terraces due to a lack of the sub-surface water flow which had previously made their utilization possible.

In short, alterations were made in the basic requirements for the integrated management of resources (including water) which had existed in the pre-hispanic era: namely, community participation, a minimum management area, and the technical know-how to carry out such management.

Fortunately, communities have survived in many areas which even today fulfil those requirements to a certain extent (as will be seen further on), and this allows solutions to the above problem to be put forward. Futhermore, in other mountainous regions of the world, such as the People's Republic of China,[25] the application of integrated methods of natural resource management can currently be observed in areas which had previously suffered severe degradation, thus providing an opportunity to witness examples of truly integrated basin management.

(c) *Post-colonial period.* The independence of the Andean countries changed the Andean peasants' situation very little as regards the use and management of natural resources, particularly water and land. The systems prevailing in the colonial era continued to predominate throughout almost all of the high Andean zone. Fortunately, however, communal practices also continued to survive, despite the lack of effective support.

Nevertheless, the gradual changeover to private ownership of the land and water, together with the exploitation of the high Andean peasants, exacerbated social, economic and technical problems. All of this generated political movements concerned with improving the peasants' lot, as is illustrated by the number of activities initiated in recent years to aid mountain residents.

Thus, measures began to be taken as regards agrarian reform, technical assistance for peasants, State ownership of water, implementation of regional development and water management projects, and other efforts which have had varied results, primarily depending upon their effect on the three factors already mentioned as being essential to natural resource management in the Andean region: (i) communal participation and organization; (ii) land area (both surface area and vertical space); and (iii) scientific and technological development adapted to local conditions.

Probably the most important efforts made recently are those directed toward river basin management and the integrated management of hillsides which enlist the active participation of area residents, using systems such as that promoted by the Inter-American Centre for Integrated Land and

[24] H. Villanueva and J. Sherbondy, *Cuzco: Aguas y poder, op. cit.*

[25] The best known example is the reclamation and terracing initially carried out by the commune of Tachai, which later spread throughout modern China. The projects are very similar to those undertaken during the pre-hispanic period in Peru.

Water Resource Development (CIDIAT).[26] In this respect, governments that have taken significant steps to consolidate the financial and institutional systems which guarantee the continuity of such activities are materially contributing to the solution of environmental management problems in the high Andean zone.[27]

Another important line of progress is connected with the promotion of administrative improvements in environmental management activities, particularly those which place special emphasis on institutional factors such as organization, the development of suitable working methods and the like.[28]

III
Water in the life of the Andean peasant

1. *Main characteristics of water use*

The water problem in the Andean environment has forced the local peasant to use this resource efficiently and carefully in order to cope with periods of low water or dry spells, as well as to protect himself from the destructive effects of the rainy season. In general terms, it can be said that the Andean peasant:

(i) tries to manage surface water at its source, seeking to regulate and collect it in the highlands and to guide it through canals or natural streams to the sites where it is used;

(ii) makes every possible use of rainwater and, in particular, tries to control surface run-off by modifying the slope of the land and by constructing catchment systems;

(iii) has a highly developed sense of communal labour in the construction and organized management of water development systems, which continues to be a driving force in water management in the Andean region today;

(iv) has differential priorities for water use, depending upon its original source, preferring to use groundwater (springs) or surface water for the population's water supply, and the water from rivers and streams for irrigation, mining, the generation of power and fish culture.

As a result of the alteration in their forms of organization and the poor distribution of their land, Andean inhabitants have lost the ability to manage their water resources and/or lack the technical means needed to do so. This has created a heavy demand for technical assistance to solve their problems, and to a greater or lesser degree, they primarily look to the State for the satisfaction of this demand. This indicates that the peasants are not unaware of the importance of managing water resources, but it also shows that they have lost the bases for self-sufficiency in areas which they had mastered in the past.

The greatest demand for water resources in the high Andes is for agricultural use –either through irrigation works or improved rainwater collection– and drinking water; these are followed in importance by the demand for uses related to power generation, mining and fish culture.

There is no doubt as to the importance of improved agricultural water use in the

[26] Pedro Hidalgo and Jacobo Duek, "Estudio de los conflictos en la planificación de las cuencas hidrográficas", unpublished paper of the Reunión Regional Temática de Cooperación y Coordinación Interagencial sobre Ordenamiento Ambiental de Cuencas Hidrográficas, CIDIAT, Mérida, Venezuela, January 1982.

[27] ECLA, *Manejo de cuencas y desarrollo de zonas altas en América Latina*, document E/CEPAL/L.253, Santiago, Chile, October 1981.

[28] Axel Dourojeanni and Terence Lee, *La gestión ambiental y las grandes obras de infraestructura hidráulica*, document E/CEPAL/PROY.6/R.2, Santiago, Chile, October 1981.

high Andean region, at least in countries such as Peru and Bolivia, in order to increase agricultural yields per unit of area, to create more jobs and to reduce the risk of erosion.[29] The value of irrigation was clearly demonstrated by a study conducted on the upper Vilcanota river basin, located in the Department of Cuzco in Peru.[30] This basin, which has a surface area of some 715 000 ha upriver from the town of Pisac, contains some 47 000 ha of farmland, 25% of which is irrigated, while the remainder is used for dry farming. The more intensive use of irrigated land was demonstrated by the fact that during a year of normal rainfall, only 14% of the area under irrigation was left fallow, compared with 60% of the rain-fed cropland. Upon comparing the yields of rain-fed and irrigated crops, it was found that the yield of the latter was 19%-56% higher in a year of normal rainfall. Moreover, rain-fed crops are only produced once yearly and unirrigated fields are generally left fallow for several years at a time. The important role played by altitude was also confirmed. At elevations between 3 000 and 3 900 metres it was seen, for example, that maize production with irrigation dropped by 140 kilos for every 100 metres of altitude (local yields range from 700 kg/ha at 4 000 metres to 2 400 kg/ha at 3 000 metres above sea level).

Although the value of irrigation has been established, the importance of improving the utilization of rainwater should also be stressed. In countries such as Peru and Bolivia, on average no more than 20% to 25% of the highlands can be irrigated; the remainder must be used for dry farming, and this is precisely the area in which the greatest rural development and soil conservation problems exist due to the steeply sloping land. In these locations, community participation is even more important than in irrigated areas as far as the introduction of new techniques for hillside water and land management is concerned. This work is carried out at the farm level and requires a great deal of manpower, so that it is of direct benefit as a source of employment. Unlike irrigation projects, which are seasonal, this type of work is constant and must be carried out directly by the peasants; hence the need for technical and financial assistance from the State.

With respect to the rural population's drinking water requirements, in general the situation is critical. This can be seen from table 5, which indicates that:

(i) Rural communities (including Andean settlements) principally use water from the primary or natural source (wells or springs, collected and stored rainwater, rivers, streams, lakes);

(ii) A small percentage have access to piped water, which may even be connected to the dwellings. In the case of peasant communities, the pipes most frequently terminate at key spots in the town which serve as the public water supply centres;

(iii) Rivers or streams are an important water supply source. Andean peasants make use of the water from rivers and streams in many ways; they use it not only for drinking and cooking, but also for washing clothes, personal hygiene and watering livestock.

For the most part, the inhabitants of the Andean zone who wish to resolve problems regarding the fulfillment of their water needs lack known and effective local channels for requesting technical assistance and they teherefore address their requests directly to the central government (ministries or the President's office). A community's requests usually cover a number of

[29] Peru, according to the statistics of the National Office of Natural Resource Evaluation (ONERN) uses some 2 800 000 ha for farmland, of which more than 1 500 000 ha are located in the high Andean region. In this zone, which is called the Sierra, 17% of the land is irrigated and the rest is used for dry farming. It is estimated by the National Statistics and Census Office (ONEC) that in Peru active production takes place on 2 200 000 ha, 69% of which is in the Sierra (the discrepancy between that figure and 2 800 000 ha corresponds to the periods in which land is left fallow). It is indicated that at least some 2 500 000 rural inhabitants of the Sierra are jobless or underemployed due to a lack of sufficient land, or because the land is poorly used or in an advanced stage of degradation due to water erosion. (Carlos Zamora, *El potencial de los suelos del Perú*, internal document, ONERN, Lima, Peru, October 1979.)

[30] Ministry of Food and Agriculture of Peru, *Diagnóstico de la Cuenca Alta del Río Vilcanota, op. cit.*

Table 5

SOME FACTORS RELATED TO RURAL DRINKING WATER SUPPLY[a]

(Percentages)

	Ecuador	Peru	Average
Death rate among children under one year of age due to enteritis and other diarrheic diseases (1973-1976)	1.55	1.50	1.52
Access to piped water, % of population (1977)	9.0	10.0	9.5
House connections, % of the population (1977)	6.0	3.0	4.5
Self-obtained water supply:			
– wells	41.5	19.6	
– rainwater	1.1	–	–
– rivers	37.3	79.6	
– other	5.0	2.0	

a Adapted from Terence Lee, "Rural drinking water supply and sanitation in Latin America", in *Natural Resources Forum*, New York 5 (3), July 1981, pp. 282-290.

needs. With regard to water, it is common for them to request assistance simultaneously for the construction of irrigation, drinking water and energy facilities. If the government lacks the machinery to conduct a thorough study of the various needs, it opts for dividing up the request by distributing it to a number of sectors or ministries, which subsequently act independently of one another. At times, this creates serious conflicts as regards water development. Although this might seem easy to avoid with proper integrated planning, it is not so easy to do in practice. It seems that the most satisfactory solution would be to give greater weight to the local water authority, who should maintain a record of all current water uses and commitments to future uses in the basins for which he is responsible. There should be a single and respected local water authority who at the same time works directly with the users and serves as a link between them and the various projects scheduled in the basin, whether these are related to irrigation, rainwater management, drinking water, hydropower, fish culture or other areas. The users' requests or the government's actions should be channelled solely through that person. This reaffirms the important role of good decentralized national organization and of promoting local participation in sound natural resource managment.

2. *Extreme hydrological phenomena and the life of the peasants*

The climatic, geographic and physiographic characteristics of the Andean region make it prone to extreme hydrological phenomena which seriously affect the lives of the Andean peasants. Some of the most notable phenomena are torrential rains and the resulting flooding and landslides, droughts, hailstorms and frosts.

Torrential rains can have violent effects which completely disrupt peasant life. Such was the case recently in a region of the Peruvian mountains where very heavy and prolonged rains caused great loss of human

life and property. In connection with a recent storm, it was reported that "...In the Lucre district, 40 km from the city of Cuzco, the picture is one of devastation. More than 3 000 of a total of 4 800 inhabitants have been left out in the streets... nearly 80% of the dwellings have been flooded. Not all have fallen as a direct consequence of the violence of the flood, but one after another they have begun to collapse eroded away by the two metres of muddy water which is flooding more than 300 houses... In Cuzco there have been seven deaths, the number of houses destroyed verges on one thousand, and there is a latent danger of the imminent overflow of several lakes...".[31]

Droughts,[32] for their part, are a phenomenon which primarily and most frequently affects the altiplano region. Their aftermath, although not so spectacular as in the case described above, seriously affects agricultural and livestock production, at times provoking massive migrations.

Hailstorms and frosts can also cause a great deal of damage to the peasant economy, as they may ruin many crops when they occur at crucial stages in the plants' growth. For this reason, the central portions of the pampas –inter-Andean valleys which are more prone to frost damage than the adjacent hillsides– are usually reserved for pasture land.

3. *Integrated water use in an Andean peasant community*

Figure 2 is a schematic illustration of the integrated use of water resources by the community of Aucará in the Department of Ayacucho, Peru. This community, the residential centre of which is located 3 200 metres above sea level, possesses rain-fed croplands at an elevation of 4 000 metres, where any member of the community may grow any crop he wishes. The irrigation system comprises two intakes off a permanent river, two reservoirs (one for annual regulation and the other for daily regulation), and a network of primary and secondary canals for irrigating terrace crops (which are spread out at altitudes ranging from 3 200 to 2 500 metres above sea level). A series of springs whose waters are stored during the night for daytime irrigation is also used, making possible permanent crops such as alfalfa. The population's water supply comes from a spring located in the lower part of the village, a communal channel, and a network of pipes which carry stored water collected from a spring in the town's heights.[33] This latter use has, however, created conflicts because many villagers used this water to irrigate approximately 100 ha of terraced fields. In such cases, the solution might be to construct reservoirs at approximately 4 000 metres to store rainwater in the relatively flatter zones; this would allow for a larger water storage area even though the catchment area would be smaller. Due to its complexity, however, this would obviously be an expensive solution, and thus could not be implemented without government technical assistance. Unfortunately, the means of access to the government are unsatisfactory and the procedures slow and tedious; obtaining State assistance is therefore unlikely. Even if the government is contacted, the State will first attempt to investigate whether there are other communities also requiring assistance before conducting the relevant studies, and all this may cause years of delay in the execution of projects needed immediately by the village. This is one of the major water development problems which the Andean peasant faces when his village does not come under a specific plan for State support.

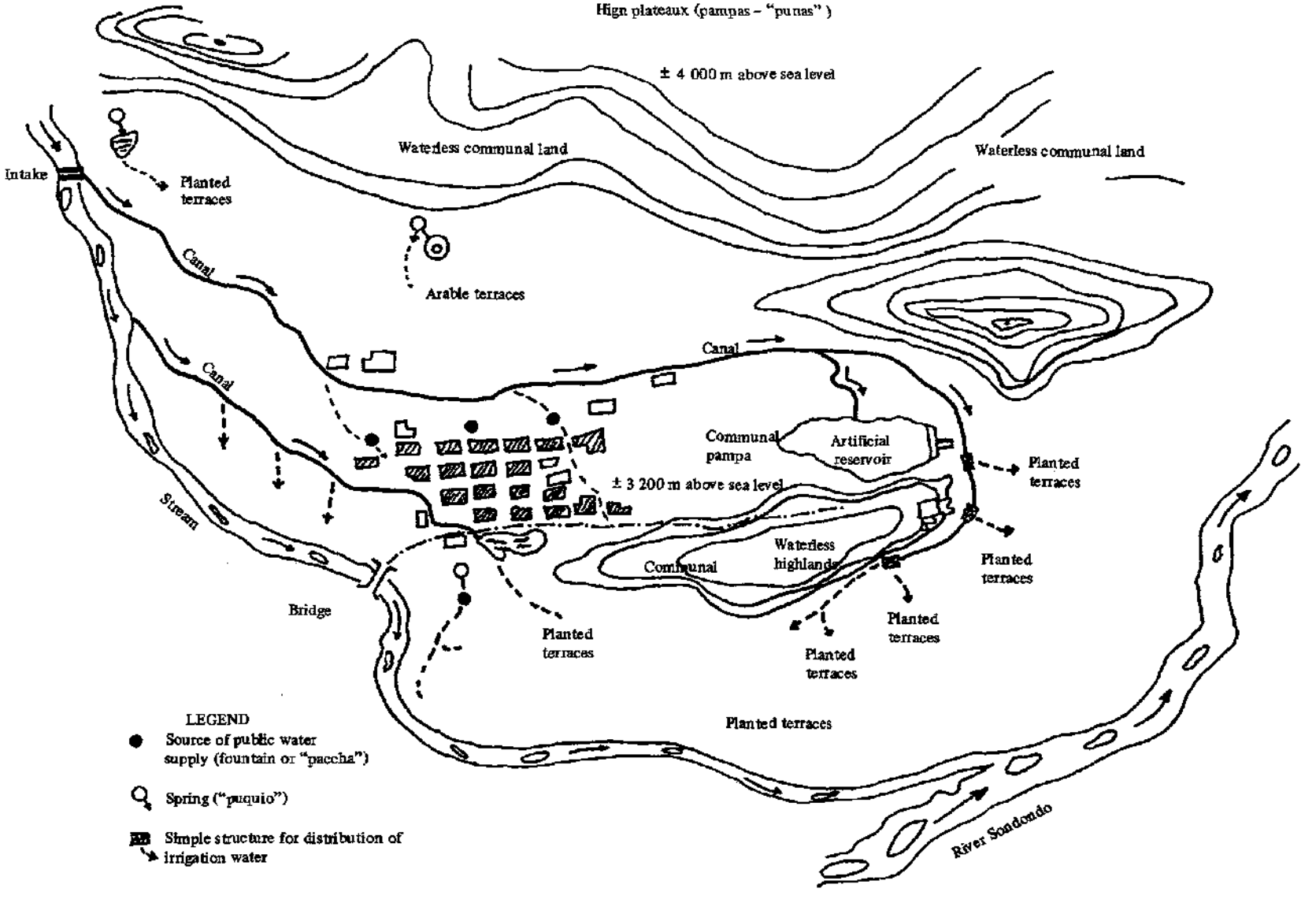
[31] A. Bermúdez and A. Solimano, "Cuando las lluvias matan", in the magazine *Olga*, phase V, No. 62, February 1982, pp. 18-22.

[32] Alan D. Hetch, "The challenge of climate to man", *EOS Transactions*, American Geophysical Union, Vol. 62, No. 51, New York, December 1981, p. 1193.

[33] Medardo Molina, "El agua en la comunidad de Aucará", *op. cit.*

Figure 2

DIAGRAM OF WATER-USE SYSTEM IN THE AUCARA COMMUNITY, DEPARTMENT OF AYACUCHO, PERU



IV
The State's role in managing the water resources of the high Andean basins

1. *Factors to be considered in water management*

In the semi-arid Andean zone, water is an essential resource for the development of its communities, and promoting its proper management is therefore an obligation. The basic features of such management can be deduced from past experiences, and may be summed up as follows:

(i) Water resource management is not an isolated activity separate from the management of the other natural resources in a basin, nor can it be approached piecemeal. It must be undertaken in co-ordination with other activities, especially proper land use at the different ecological levels or slopes and riverbeds, which are the water's origin and path.

(ii) The inhabitants of the Andean slopes or basins are the focal point of, and directly responsible for, the management of the basins and their natural resources, especially the soil, plant life, water and wildlife. For this reason, technical assistance from the State or any other source should tend to reinforce the organization, participation and training of the inhabitants with respect to the proper use of those natural resources.

(iii) In order to manage the water resources of the high Andean region properly, a certain minimum extension of land, both in terms of surface area and vertical space, is required in order to make the simultaneous control of several ecological levels possible. The ideal management units are river basins or, lacking that, entire slopes along which the flow and use of water can be controlled.

(iv) State action in the management of water resources and natural resources in general in an Andean basin should be based, as indicated previously, on promoting the participation of inhabitants and users. To this end, solid decentralized and permanent financial and institutional systems should be created which make it possible to ensure the coverage and continuity of government assistance and thus to make the rural inhabitant self-reliant.

There are various programmes and projects in Latin America for the management of water, soil, forests and wildlife in the upper basins which take into account either all or some of the considerations discussed above. The most suitable approach would be for these programmes to be duly institutionalized, with national coverage, so as to enable ongoing technical assistance and guidance regarding integrated natural resource management to be provided to users. This would mean dividing the country into administrative units for natural resource management and organizing the users to draw up and implement management plans at the individual unit level for those resources with the government's technical and economic assistance.

In practice, this has been achieved only partially in Latin America. In Peru, for example, irrigation districts[34] have been created which encompass the area of a basin or system of basins. These districts are under a single water authority whose duty it is to ensure the rational use of that resource whatever the user sector concerned. In Peru, in other words, the irrigation district is the equivalent of a water and soil district, since its sphere of action is not circumscribed by the perimeters of irrigated land within a basin nor limited to a single water use, but rather covers the entire area of the basin and all water uses. In each district a board of users has been created which performs the task of operating and maintaining water

[34] Republic of Peru, *Ley General de Aguas y sus Reglamentos*, Decree Law No. 17752 of 24 July 1969, Lima, Peru.

works, particularly irrigation facilities. However, resource management and conservation activities in non-irrigated areas, especially those located in the upper portions of the basins, have not yet been developed. The Peruvian government is currently working on this task. In Venezuela, a basin conservation programme exists at the national level, but its emphasis at present is on the management of upper basins with the participation of the users, rather than on irrigation (the reverse of what is happening in Peru). Both the Peruvian and the Venezuelan programmes are of national scope, encompass the whole of each basin, and are based on user participation. These programmes could serve as the starting point for increasingly integral management of renewable natural resources, which, in addition to water and soil, would include forests, pasture land and wildlife, as appropriate.

Unfortunately, these are isolated and often incomplete examples. In general such programmes suffer from a lack of State support since, for various reasons, the governments of Latin America do not assign the necessary importance to national-scale management and conservation activities. They choose instead to direct their investments, at best, toward specific programmes for the integral development of a few basins or, more commonly, toward highly sectoralized programmes for water, soil, forest or wildlife development, without basing such programmes on an integral plan for natural resource development, without taking in the minimum land area –such as a basin, an entire slope or several ecological levels– and without satisfactorily enlisting the participation of the users at all times, from the plan preparation to the implementation stage.

Hence with regard to water, for example, there are often national programmes for small and medium-sized irrigation projects, national programmes for the construction of small hydroelectric plants, national rural drinking water supply programmes, etc., which literally plant water projects in basins without any co-ordination. In addition, their activities are customarily limited to the construction phase of these works: they neglect the subsequent stages of the operation of the systems built, as well as those of water management and conservation, and, what is more, fail to enlist sufficient participation by basin users. The same thing may occur in plans for reforestation, wildlife management or the promotion of specific crops, when they do not constitute an integral plan for natural resource development and management.

If users participate in these programmes, they are faced with the problem of having to deal with different government agencies, depending on the sector to which they belong or the resource which they are attempting to manage. In addition to the technical difficulties involved in carrying out projects in an orderly manner without an integral plan, this creates a lack of concern or an inability on the part of local residents to involve or identify themselves with programmes which the government is trying to establish in the area where they live. It is therefore important for the State to be sufficiently well organized to provide its assistance in a well-planned way, seeking to facilitate and promote the users' contribution, in order to ensure the long-term management of renewable natural resources in mountainous areas.

2. *Water resource management programmes and projects involving community participation*

One very positive element in Latin America in general and in the Andean area in particular is the long list of programmes and projects aimed at promoting community participation and integrated use of renewable natural resources. Some of these programmes and projects, including those of Venezuela and Peru, are described below. In the aggregate, they represent a very important body of experience which has still not been shared and used to the fullest extent possible. An adequate study of this experience could produce valuable conclusions which would be of general benefit to the countries of the region. The most important programmes include:

(i) The National Plan for Improvement

of Irrigation in the Sierra (the MERIS plan) of Peru. This plan is aimed at furnishing technical assistance and financial support to local communities for the development of small irrigation projects in the Peruvian sierra. Its approach is based on a previous evaluation of major Andean basins in order to identify their principal physical and socio-economic characteristics and to discover potential irrigation sites, as well as on planning and executing the respective projects with local participation and user training. Activities have been conducted in the inter-Andean basins of Cajamarca, Upper Mantaro and Upper Vilcanota. It provides a good example of a plan of action for the development and sectoral management of water at the basin level.[35]

(ii) The Social Infrastructure and Conservation Programme of the Venezuelan Ministry of the Environment and Renewable Natural Resources. This is a national programme which has a specific subprogramme for the conservation-oriented management of upper basins. Its major contribution is its integral basin-by-basin focus, its institutionalization and ongoing consolidation, the systematic training of State personnel, and its encouragement of participation by basin users.[36] Technical support for this programme is provided by the Inter-American Centre for Land and Water Resource Development (CIDIAT) of Mérida, Venezuela.

(iii) The National Programme for Soil and Water Conservation in River Basins of Peru's Ministry of Food and Agriculture. The starting point of this programme, which began only recently, was the creation of management and conservation departments in Peru at the irrigation-district level. Under the country's general water law, these districts cover an area which includes the whole of one or more river basins. The programme's objective is to organize and institutionalize the functions of these departments for the performance of those activities having a particular bearing on the upper basins. It includes plans to develop methodologies and manuals for national distribution based on experiences with pilot areas and projects already completed. It also receives technical support from the United States Agency for International Development (AID).

(iv) The River Basin Management Programmes of the Corporación Autónoma Regional del Valle del Cauca (CVC) of Colombia. The objectives of this effort are the evaluation, planning and implementation of a series of programmes dealing with, *inter alia*, a realignment of basin uses, conservation, reforestation, mining development and the improvement of rural housing in the sub-basins of the Upper Cauca valley. Its goals are: to achieve short-, medium- and long-term increases in the water supply for domestic, agricultural and industrial uses; to boost agricultural and forestry productivity without damaging natural resources; and, in general, to raise the standard of living of the basin inhabitants.[37]

Other important programmes of a similar nature, although they do not necessarily concern the Andean region, are under way in a number of countries:

(i) The Sierra Plan of the Dominican Republic, whose objective is to promote rural development in a montainous area of 2 000 square kilometres in the Central Cordillera of that country;[38]

(ii) The Programme for Institutional Strengthening for Control of Erosion and Improvement of Agriculture in Haiti, which is being carried out by that country's Department of Agriculture, with assistance

[35] Ministry of Food and Agriculture of Peru, *Diagnóstico de la Cuenca Alta del Río Vilcanota, op. cit.*

[36] Ministry of the Environment and Renewable Natural Resources, Department of Basin Management, *Conservación de cuencas –Programa básico*, Sociedad Venezolana de Ingenieros Forestales, Jornadas Técnicas Forestales, Caracas, Venezuela, 1978.

[37] Corporación Autónoma Regional del Valle del Cauca (CVC), "Plan de ordenación y desarrollo de la cuenca del río Aguatacal", *Informe CVC*, No. 79-17, Cali, Colombia, November 1979.

[38] Blas Santos, "El Plan Sierra: Una experiencia de desarrollo rural en las montañas de la República Dominicana", Proceedings of the Seminario Internacional sobre Agricultura de Ladera en América Tropical, held in Turrialba, Costa Rica, 1-5 December 1980.

from the United States Agency for International Development (AID);[39]

(iii) The Executive Programme for Land Reclamation in Tarija (PERTT) of Bolivia, aimed at preventing the rapid environmental deterioration of the basins in this region, which is part of the upper basin of the Bermejo River;

(iv) The River Basin Management Programme of Honduras, initially directed at the reclamation of the basins devastated by hurricane "Fifi" and later modified to create technical and institutional bases for the management of the basins of the Sierra de Omoa in north-eastern Honduras. This project has produced technical manuals and regulations on basin management, primarily for application in tropical zones.[40]

There are other such programmes in a number of Latin American countries which can supply valuable information, even though some of them are carried out under diverse names and have varying scopes, which often creates confusion among people attempting to exchange information on the subject of basin management (see table 6).[41]

It should be recognized that the long list of programmes and projects aimed at the management of high mountain zones in Latin America has permitted significant steps to be taken in the exchange of experience and know-how among the persons responsible for projects as well as the publication, at least at a local level, of many manuals and working methods for high mountain regions.[42]

One of the most significant efforts is the creation of a Latin American River Basin Network. This network was initially promoted by the work of FAO[43] and is in full operation. The proposal to organize an international association of experts on hillside agriculture in tropical America, which resulted from a recent seminar on the subject held in Turrialba, Costa Rica,[44] should also be mentioned, as well as the goal of preparing a manual for the development and management of the upper basins of Latin America.[45]

These advances seem to point to a heightened awareness of the importance of the management of highland zones in general and of the need to pool the efforts being made to achieve such management through machinery for horizontal co-operation among countries, institutions and experts.[46] It is to be hoped that in the near future the attempts to benefit these very needy zones in the region will prosper.

[39] USDA/PASA, "Institutional strengthening for control of erosion and improvement of agriculture in Haiti", *Report* for AID, Washington, D.C., February 1979.

[40] UNDP/FAO, *Ordenación integrada de cuencas hidrográficas*, internal report to the Government of Honduras, Document FO:DP/HON/77/006, UNDP/FAO, Rome, 1981.

[41] In order to avoid these difficulties, it appears necessary to classify programmes, projects or activities according to the criteria set forth in the annex, which are derived from the above considerations.

[42] Some examples are the following: Ministry of the Environment and Renewable Natural Resources (MARNR), *Instructivo de la Dirección de Manejo de Cuencas*, Caracas, Venezuela; Ministry of Food and Agriculture (MAA), *Manual de conservación de aguas y suelos*, General Directorate of Water and Soil, Lima, Peru, January 1980; T. Michaelsen, *Manual de conservación de suelos para tierras de ladera*, Project HON/77/006, working document No. 3, Tegucigalpa, 1980.

[43] H.R.H. Haufe and A. Patino, "El intercambio de experiencias en el manejo de cuencas hidrográficas a través de la red latinoamericana de cuencas hidrográficas", unpublished document of the Reunión Regional Temática de Cooperación y Coordinación Interagencial sobre Ordenamiento Ambiental de Cuencas Hidrográficas, UNEP/CIDIAT, Mérida, Venezuela, January 1982.

[44] Tropical Agriculture Research and Training Centre (CATIE) and The Rockefeller Foundation, Proceedings of the Seminario Internacional sobre Agricultura de Ladera en América Tropical, Turrialba, Costa Rica, 1-5 December 1980.

[45] UNEP/ROLA, *Informe de la Reunión Regional Temática de Cooperación y Coordinación Interagencial sobre Ordenamiento Ambiental de Cuencas Hidrográficas*, Mérida, Venezuela, January 1980.

[46] ECLA, *Manejo de cuencas y desarrollo de zonas altas en América Latina*, *op. cit.*

Table 6

TENTATIVE CLASSIFICATION OF DIFFERENT TITLES OF ACTIVITIES WHICH INCLUDE OR FORM PART OF THE INTEGRAL DEVELOPMENT AND MANAGEMENT OF RIVER BASINS

Integral development and management of natural resources
Regional development
Microregional development
Integrated rural development
Integral development of major basins and/or upper basins
Environmental management for purposes of development
Management of reserves and natural parks
Land management/basin management
Sectoral development and management of natural resources
Integral basin management
Soil and water conservation
Agricultural/forest/range management
Management of forests, range management and soil management
Hillside planting
Treatment of slopes
Combating desertification
Specific development and management of water resources
Collection, regulation, piping and drainage of water from rain, snow or fog, and of surface, sub-surface and ground water
Basin management for purposes of discharge regulation
Protection of basins, control of erosion, control of landslides
Torrent control
Canalization of rivers and riverbank protection
Control of run-off and flood control
Control of pollution in general, control of salinity and drainage problems
Drought control

Source: *Manejo de cuencas y desarrollo de zonas altas en América Latina*, document E/CEPAL/L.253, October 1981.

V
Conclusions and recommendations

1. The inhabitants of the Andean zone are the only persons who can guarantee the proper management of the basins and the water of the high Andean region; the State should therefore direct all its efforts toward helping them to acquire the organization and knowledge required to move toward self-sufficiency, at least as regards their basic technical needs.

2. In the pre-hispanic era, at least three factors were considered essential to ensure basin and water management: (a) the organization and co-ordinated participation of the community in projects; (b) the use of technologies and work methods adapted to the zone; and (c) control over a sufficiently large land area to permit different ecological levels to be managed simultaneously.

3. To date, there are still relatively few programmes and projects which embody a clear idea of the above elements and devote their efforts primarily to providing technical and financial assistance to the inhabitants and users of the basin resources –principally

water and land. Nevertheless, the programmes which have already been begun can and should serve as the basis for making their experience known to other countries through inter-institutional horizontal co-operation machinery.

4. It is recommended that, in line with the foregoing, the inter-institutional co-operation and co-ordination networks already in existence or being created should be consolidated, and that the formation of new channels for the transfer of knowledge and experience in the field of high mountain basin management should be encouraged. To this end, it is recommended that a survey be conducted which would permit a systematic listing to be compiled of the programmes and projects concerned with the management of the high Andean zones of Latin America.

5. It should be noted that water management in the high Andes has special characteristics due to the occurrence of prolonged annual and inter-annual droughts, abruptly interrupted by periods of heavy rainfall which, in combination with the high altitude and steep slopes, makes its control extremely complex.

6. In general, the upper basin projects developed in Latin America are mainly of a sectoral nature, being concerned, for example, with water development for residential or agricultural use, or the development of a given crop. Although this provides a valuable source of information for more integrated projects, it is evident that there is still a lack, except in rare cases, of more complete projects combining, for example, agricultural, forest and range management of wildlife management with the construction of major water works as part of an integrated basin development scheme.

7. An important task to be undertaken is the strengthening of institutions of national scope responsible for the integrated management of basins or natural resources through user participation. Some countries are now gaining experience in this regard which may serve as an excellent frame of reference for other Latin American countries. It is recommended that a study of the progress made in this area be carried out in the region.

8. Although scientific research and experimentation are obviously necessary in order to conduct basin and/or water management projects in the Andean region, it is felt that the mere observation of what has already been done or is being done in the various countries working along these lines would make it possible to identify and develop widely applicable methods which would require only minor adjustments to permit their adaptation to other locations.

9. It should be emphasized that water is a part of the environment and that therefore its conservation and, particularly, its ready availability and control are a function of the way in which its natural collection sources and later successive uses are managed.

10. It should be stressed that a close parallel exists between modern concepts of basin management –understood as an administrative activity directed toward developing and protecting the natural resources present in a basin– and the age-old concept of vertical control of different altitudinal or ecological levels which was already known to the Andean inhabitants of pre-hispanic times.

11. It should also be understood that the Andean peasant is generally a person with team spirit and a sense of association with the environment and that, therefore, there is a basis in his own community underlying his self-motivated actions in connection with natural resource management. This is why it is stressed here that the State should –at least initially– encourage this self-sufficiency with respect to the development and management of the water and land resources, with a view to eventually broadening that management to include other resources such as plant and animal life and steadily reducing the inhabitants' reliance on outside assistance as they gradually regain an awareness of their own capabilities.

12. It is recommended that great emphasis be placed on the training, in line with a uniform approach, of national personnel responsible for promoting the proper development and integrated management of

upper basins. In order for this to be done, manuals and methods must be developed which permit the wide dissemination and application of the technical and administrative know-how applicable to mountain areas as well as techniques for promoting the participation of rural inhabitants. There could even be a single manual for the Andean area if the countries concerned wished to join forces in order to prepare it.

13. Finally, it is recommended that local water and land management authorities for the river basins of the upper Andes, representing both the State and users, should be created or strengthened. Such authorities should be backed by concrete support from the government, given the fact that they are the agents of, and directly reponsible for, the management and conservation of the water and land and hence of an important phase of environmental management. The State water authority at the level of basins must, however, be a single entity which is respected by all sectors using that resource in order for development to be both rational and efficient.

Annex
Criteria for the classification of development and management projects for high-mountain river basins*

1. *Criteria regarding participation by basin residents*

(a) The project is carried out by the residents on their own initiative and with their own resources.

(b) The project is carried out by the residents with State or private technical and economic assistance.

(c) The project is carried out by the State or private companies, but local manpower is used.

(d) The project is carried out by the State without enlisting the participation of basin residents.

(e) Only some of the basin residents participate in the project.

2. *Criteria for territorial coverage*

(a) The project includes the entire area of one or more basins or hydrographic units.

(b) The project includes only part of the area of a basin, but it is a manageable hydrographic unit, generally an entire slope or the upper sections of a basin.

(c) The project covers only part of the hydrologically manageable area of the basin: the lower section, middle section, right bank, left bank, bed or a reach of a river, a human settlement, or other areas demarcated by non-hydrological boundaries.

3. *Criteria for sectoral and technical coverage*

(a) The project covers aspects which include all sectors of development: agriculture and livestock, forests and wildlife, energy, transport, communications, fishing, recreation, education, health, etc.

(b) The project covers only one sector of development, but that sector is dealt with integrally, e.g., farm, forestry, range and wildlife management within the agricultural sector.

(c) The project covers only one sector of development, and within that sector, is limited to a single activity such as the development of a crop, the improvement of irrigation or the protection of a slope.

(d) Regardless of its sectoral coverage, the project encompasses one or all of the technical phases required for its execution, i.e.: (i) *studies* (inventories, surveys, appraisals and assessments); (ii) *preparation* (project design and preparation); (iii) *ex-*

* Prepared by A. Dourojeanni.

ecution (main, secondary and auxiliary projects and follow-up work); (iv) *operation and maintenance* (organization of the users for the operation, maintenance and repair of the facilities constructed); and (v) *management and conservation* of resources (systematization of the use of basin resources; management, protection and preservation of those resources; and reclamation or recovery of degraded resources).

4. *Criteria regarding project orientation*

The project's objectives are:

(a) To direct and carry out the development of a given basin or area.

(b) To institutionalize the actions of the agencies responsible for basin management or similar activities.

(c) To investigate and test techniques and to develop manuals and methods.

(d) To provide technical assistance to users.

(e) To provide financial assistance for basin management activities.

(f) Other.

5. *Institutional/operational criteria*

(a) The project organization is directed toward promoting the development and/or management of a number of basins simultaneously, either at a national or regional level, and a network of agencies is available for this purpose.

(b) The project organization is specifically for the performance of activities in a single basin or part of one.

(c) The project organization is: (i) permanent, (ii) temporary, (iii) provisional, and is intended to cover all or only some of the technical phases required.

(d) The project organization is subordinate to a specific State system in the (i) administrative, (ii) technical, or (iii) financial area or areas.

(e) The project organization is autonomous, and its administrative, technical and financial systems are its own direct responsibility.

(f) The project receives technical and/or financial assistance for its operations from external sources, the government, or private bodies.

(g) The basin management project is part of a specific sectoral project –e.g., an energy or agricultural (irrigation) project– and its administration comes under the authority of the sectoral project administration.

6. *Other criteria*

In addition to the criteria outlined above, others may be included regarding the project's location, duration, the results desired, the technical personnel involved, its organizational structure, supporting legislation, the degree of inter-institutional coordination, the publications, manuals and methods produced, the training and extension systems employed, the technologies developed, the sources of funding used and, in general, the features of the managerial systems which make the promotion and execution of basin management programmes in Latin America feasible.

These would permit the possible preparation of a survey to classify and assess basin management projects in high-mountain areas of Latin America, such a task being considered a necessary step toward increasing co-operation among countries.