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TRADITIONAL IRRIGATION IN THE ANDES OF ECUADOR

DYSFUNCTIONS AND REHABILITATION

by P. LE GOULVEN[1], T. RUF[2], H. RIBADENEIRA[3]

Abstract

The multidisciplinary team of the franco-Ecuadorean ORSTOM-INERHI project presents a synthesis of various dysfunctions which were identified during the surveys on traditional Andean irrigation areas in northern Ecuador.
The features of the diagnosis are formulated at different levels: relations between watersheds and ZARI (Zone of Analysis and Recommendations for Irrigation); between ZARI and irrigated areas; between irrigated areas and farming sistems; between farming sistems and crop plots.
It shows that the water shortage may be the result of many combined dysfunctions that have a negative impact on farmers' decisions: they prefer extensive forms of agriculture and therefore obtain low land productivity.
The authors propose as a preliminary task, in order to prepare the National Irrigation Plan, prospects to structure and organize the traditional networks.

1 ORSTOM Mission, P.O. Box 17.11.6596, Quito, Ecuador
2 ORSTOM Mission, P.O. Box 17.11.6596, Quito, Ecuador
3 Plan Nacional de Riego, INERHI, Quito, Ecuador

The first report, *Traditional Irrigation in the Andes of Ecuador, (1) Research and Planning,* showed how an international and multidisciplinary team had built a research methodology to prepare a Traditional Irrigation Development Plan. We emphasized how much this irrigation did not follow the usual standards. The originality of these systems,. especially linked to the mountainous topography and history, justifies the research work on what does not function well along the water mobilization and utilization chain at different levels of the ZARI (Zone of Analysis and Recommendations for Irrigation).

From detailed studies of four ZARI that were selected as most representative, Urcuquí, Pifo, Santa Rosa and Guamote, the major features of the diagnosis on the dysfunctions of irrigation in the northern Ecuadorean Andes were formulated and the first channels of improvement of the private networks started to be defined (see Fig. 1. Organization-Type of a ZARI and Location of the Different Problems).

Urcuquí, introduced in the first report, is a ZARI of the dry Mira watershed in the northern Andes; it is made up of approximately 5,000 hectares irrigated by 17 traditional systems. Pifo is located close to the capital Quito. Therefore, this ZARI, with its 2,800 hectares irrigated by 12 traditional systems, evolves under the influence of of the urban outskirts. Santa Rosa and Guamote belong to the Pastaza watershed, located in the middle of the country. These ZARI represent totally opposed situations.

- the first, Santa Rosa, is exemplary owing to the high degree of artificialness of the Andean environment (very high population density – 300 inhabitants per square kilometer, 8,000 hectares irrigated by large traditional systems from 30 to 50 kilometers long, irrigated continuous crop systems in farming units of less than one hectare);
- the second, Guamote, is a crisis area, abandoned by its inhabitants, and only the sectors that have irrigation networks (of limited scope) remain populated, even though they are deeply affected by seasonal migrations.

1. SUPPLY DISFUNCTIONS AT THE WATERSHED LEVEL

1.1. Very poor low-water flows, owing to severe drought even in the high-mountain areas

Areas that are potentially irrigable do not have any facilities. In the river watershed, only a dam would allow to increase the supply during the dry season. In certain cases, a transfer from a neighboring watershed that has a supply which exceeds the demand could solve the water shortage problem. These cases are rare. They imply prior legal and political agreements and sometimes high investments if the transfer requires special work (tunnels). This problem goes beyond the limited field of rehabilitation.

1.2. Large but inaccessible flows because the gorges are too narrow, the geomorphology is unfavorable, etc.

As before, the areas suffer from a shortage of water, but this time the farmers see the water pass at a few tens or hundreds of meters beneath their land. In certain cases, a dam to raise the water level could facilitate the installation of facilities or the enlargement of those that already exist.

1.3. Highly variable hydrological rhythms with sudden and destructive overflows

The water intakes are regularly flooded. The irrigated areas are periodically deprived of water. If the damage is considerable, the farmers run the risk of losing part of their crops.

This type of accident (we will see later on that there are many more) becomes even more dramatic if the social organization that manages the system is disorganized.

A modern intake construction program could make the irrigation systems in the aggressive watershed less vulnerable.

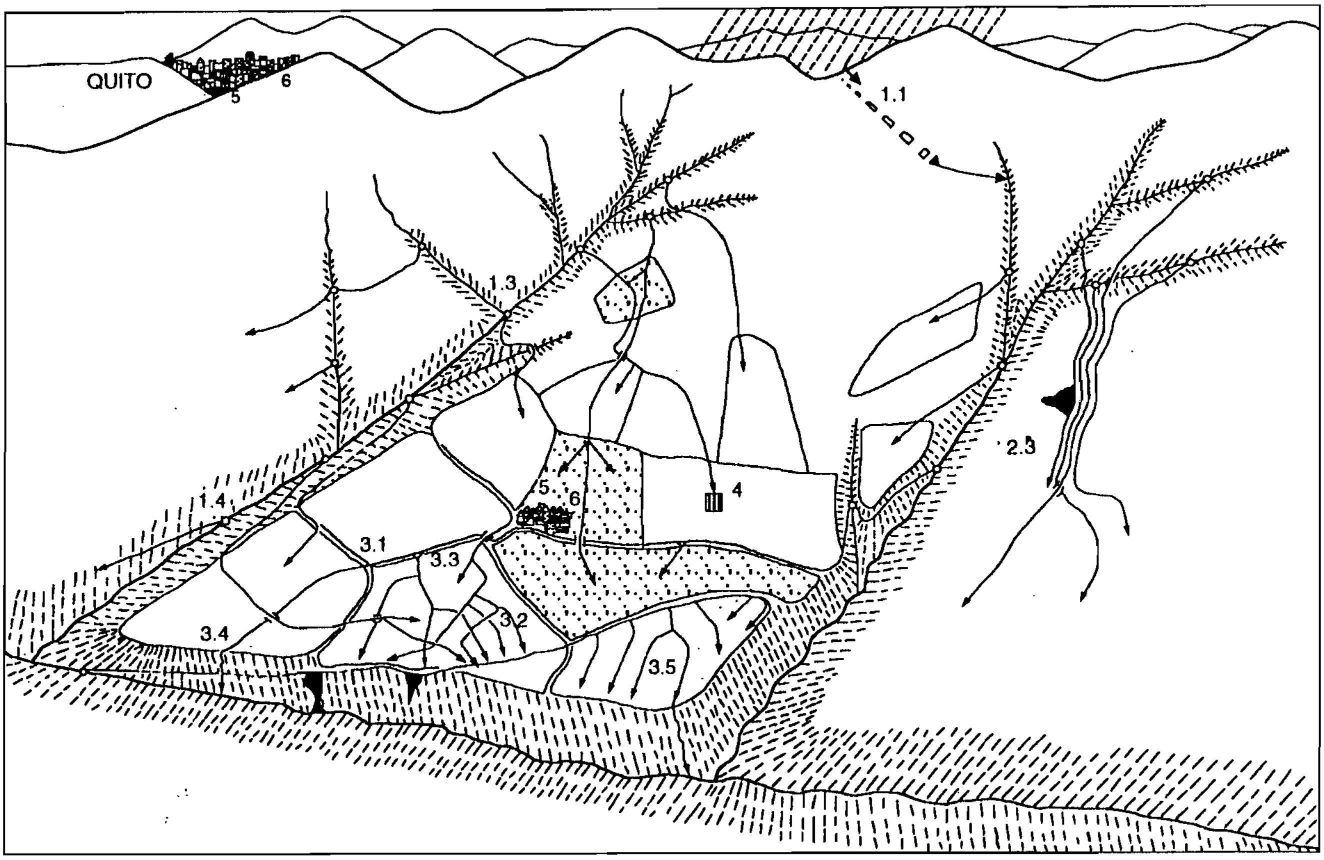

Figure 1 - Scheme of a ZARI with localization of major identified problems

1.4 Drying up of the river downstream from a series of outlets

The areas that are irrigated from downstream intakes systematically run the risk of being short of water. This situation is often the result of a lack of coordination to manage the water resource. It may be accompanied by downstream/upstream conflicts that can go as far as an "intakes war", that is, the alteration and sometimes even the destruction of the facilities.

Solutions to this problem are not easy, because each of the groups involved claims inherited water rights.

In this type of case, it is better to no longer grant any additional concession and to organize a joint effort among the irrigating organizations.

The installation of the intakes and the discharge regulators planned in the concession documents should indeed be carried out with financial and technical support.

2. DEMAND PROBLEMS AT THE INFRASTRUCTURAL LEVEL IN THE ZARI

2.1 Poor average continuous fictive discharge, owing to lack of available water resources in the watersheds that feed the network

This case is a translation of the two first kinds of problems already described concerning the watersheds.

When the watersheds do not function in the same way, it may be useful to restructure the networks combining the supplies of the two watersheds towards the crest of the interflow.

Thus a greater regularity and security of the distributed flows would be obtained.

2.2 Considerable disparity in the distribution of the supply, even taking into account the normal variabilities owing to the altitude

Certain irrigated areas are supplied by a continuous fictive discharge of 2 liters per second per hectare whereas others have only 0.1 or 0.2 liters per second per hectare.

In the landscape this gives a mosaic of highly heterogeneous areas with respect to crop-raising during the dry season.

In the case where the water resource is limited compared to the requirements, it is possible to revise the concessions or, by installing modern intakes, to avoid excessive impoundments of water which would be detrimental to the other systems located downstream.

When the water resource is not limited, an enlargement of the deficient systems could be considered. A poor supply may be due to the deterioration of the canal owing to a lack of maintenance.

For instance, the absence of maintenance to clear the sand from certain parts may, over time, considerably minimize the channel discharge capacity and reduce even more the water supply of this or that system.

2.3. Too high canal density, which makes it very difficult to maintain all the systems and provides linear or punctual losses, whether of natural or social origins (theft, conflicts)

One solution would consist of simplifying the network especially when the canals run along parallel lines.

Moreover, in this type of situation, chain accidents occur when the upper canal breaks following an overflow or a mudslide.

The weakest areas should be reinforced by means of special works and protected from streaming if the latter produces dangerous overflows.

Protection against erosion and soil accumulation in the canal can be improved by planting thick hedges above the canal segments in question.

Finaly, we have observed that certain sectors are very difficult to reach. Their maintenance would be facilitated if accessways and maintenance roads were built.

3. DYSFUNCTIONS IN THE DISTRIBUTION IN THE ZARI

3.1. Absence of a rotational working, as a consequence of which there is an unequal distribution among the upstream and downstream users on the distributors

This lack of rules and regulations to share the water resource occurs in four kinds of cases:

- the number of users is low and water distribution is decided upon from day to day according to the needs of each user; over time and with the parceling of the land, the number of users increases and the first difficulties arise;

- the users have just acquired a concession over the canal, for example, when haciendas are divided into lots and sold, and they do not know how or are unable to get organized to set up a rotational system;
- the users were organized to set up a rotational turn distribution, but because agriculture is no longer a prime activity, the rules have been more or less ignored;
- the users are organized but their number is so large –and their conflicts so intense– that the rotational system does not operate well; the planned schedules are not adhered to, the accumulation of delays leads to irrigation cuts.

3.2. Very long transport time in the distributors which sometimes consist of a veritable maze of intermeshed water courses

The distribution systems can be explained by the history of transfers of water rights and the sales of user time for the various distributors.

Its efficiency is poor insofar as the water does not always run from one plot of land to the next but rather follows the order established by water rights.

A reorganizaton of the rotational working would be desirable, although this is generally hard to accept by the users who are accustomed to certain irrigation schedules, especially when this requires that the irrigation take place during night hours.

The distribution could be modernized by installing a permanent module for each sector which would be managed by the respective group of farmers.

To ensure a minimum of fairness in the distribution from a given module, it would seem that the safest method of distribution would be the one that delivers the module first to the last user of the distributor and then the outlets would be open from plot to plot until it reaches the first user (this already exists in certain systems).

Sometimes the distribution works on an alternating basis, so that the last user of the water schedule would become the first for the following irrigation and vice-versa.

3.3. Considerable irregularity of the modules delivered from one irrigation to another, owing at the same time to the abovementioned dysfunctions in the watersheds and the facilities, but also owing to the fact that the generally rustic dividing junctions do not always distribute the discharge that come to them in the same way

In reality, the problem is not so much the distribution of water among users but rather the distribution, when it does exist, of the water shortage in the fairest way possible to the users.

Providing the networks that suffer from a considerable flow disparity with proportional outlets seems quite attractive.

3.4. Considerable losses during the night when the farmers do not use night irrigation or put it into practice carelessly and when there are no tanks

Night irrigation on steep slopes is always difficult to manage. During the night water theft is most frequent, and it is at this time that it is most difficult to reestablish the normal discharge.

The installation of a tank with a capacity that corresponds to the night stock would be an invaluable aid for managing the traditional systems. Such programs already exist, but without a systematic modernization of equipment in an entire ZARI.

In the absence of a tank, there are several solutions available to distribute the night hours to all the users.

The night hours can be assigned on an alternating basis each year. This solution, which seems equitable, hardly modifies the night losses; it only obliges everyone to share the unfavorable conditions every other year.

The frequency of the water shift can also be modified, adopting a period based on an incomplete number of days. For example, instead of seven days, the period could be six days and a half, with one day of service interruption after two periods or two days every four periods for carrying out network maintenance. Thus, each farmer irrigates on an alternating basis during the day and at night during the whole year.

This arrangement can be refined even further by using a period of six days and three fourths, which would lead the users to set back their irrigation schedule six hours from one shift to another and to limit the service interruption for maintenance purposes to only one day every four weeks.

Such changes are hard to effect for they upset habits and interests that have been well established over a long time. But if these changes are thoroughly explained and if they are able to convince the users as a whole, it is possible to considerably improve irrigation conditions both fairly and safely.

3.5. Frequency of irrigation that is poorly suited or inappropriate for intensifying agricultural production systems

There are areas where the rotational turn takes place over a period of 15, 16, 17, or even 21 days, which virtually prohibits the farmers from choosing crops that demand a great deal of water, during dry seasons when requirements are very high.

It must be emphasized that the usable soil reserves are often poor; the Andean soils contain a high proportion of sand, to such an extent that certain irrigated soils are deemed unsuitable for irrigation in the international manuals. One frequently finds easily usable reserves on the order of 30 mm, which requires an irrigation frequency of about 7 days and not 14 or 21 days.

It is not an easy task to manage this problem for it is generally linked to a considerable disequilibrium between supply and demand.

So that each user can enjoy the privilege of a decent dosage of irrigation, taking into account the time consumed in transfers, the rotational turn should have to be prolonged, but the longer it is the less useful is the irrigation.

Moreover, the risk of having the irrigation withheld is undesirable, as it would mean that the crop under cultivation would have to wait one month or more without any artificial supply. The peasants can only then rely on a redeeming storm, which is paradoxically when one knows that an irrigation infrastructure does exist.

Shortening the frequency would imply significantly increasing the supply.

4. APPLICATION DYSFUNCTIONS AT THE SMALL PLOT LEVEL

4.1. Unsuitable module

- A module that is sometimes too weak (lower than 5 liters per second), which implies, on the one hand, very long irrigation times by hectare (up to 24 hours or more) and, on the other hand, application difficulties with respect to the arrangement of the furrows: the former sectors end up by being over-irrigated whereas the latter are under-irrigated.

- A module that is sometimes too strong (more than 20 liters per second), which produces erosion because there is no way to control the volume of water that keeps coming into the plot of land. Only by creating buffer tanks would it be possible for the irrigators to select a module that is suitable for their soil, work, and rotational system limitations.

4.2. A poorly performing irrigation arrangement

- In certain cases, the irrigator merely "throws" water over the upper part of the plot without ever directing it. The water follows the micro-thalwegs and ends up generally by going out of the plot until the irrigator returns.

- In other cases, the irrigator does not optimize the distribution of water: in accordance with the module he has at his disposal and his soil characteristics, he can take advantage of the length of the furrows and work time to correctly distribute the amount of water that reaches the totality of the plot.

It is obvious that the users do generally lack appropriate technical advice and the necessary technical know-how to improve the application.

To explain the water shortage that the irrigators complain about, there is also the fact that they all waste water in their fields.

The promotion of small experimental stations managed by the irrigator associations with tecnical support would allow for a better rationalization of the applications.

5. PRODUCTION SYSTEM FUNCTIONING PROBLEMS AT THE AGRICULTURAL DEVELOPMENT LEVEL

In addition to the eventual limitations linked to the shortage of water, there are a series of socioeconomic and technical problems that the farmers take into account when they choose their productions and implement agricultural techniques: lack of capital, credit, equipment, labor force; uncertain marketing outlets; lack or organization and market control.

Other factors lead to various difficulties: extreme parceling of the plots in certain irrigated areas, which makes the distribution all the more complex.

In such conditions, water usage proves to be extensive and is sometimes limited to irrigating natural prairies in order to maintain cattle whose main function will be economic: it will allow the farmer to rely on saving in an uncertain economic environment.

With this respect, it is quite curious to note that in Ecuador there is virtually no stocking of fodder neither among the peasants nor in the haciendas.

These aspects of farm management lie outside INERHI's traditional field of intervention.

Nevertheless, they must be taken into account as a part of the planning.

For example, it would be meaningless to rehabilitate the network in a ZARI which has been abandoned by its inhabitants who have gone to work in the city.

6. DIFFICULTIES EXPERIENCED BY THE IRRIGATING ORGANIZATIONS IN THEIR INNER AND EXTERNAL RELATIONSHIPS

We are at present witnessing a multiplication and atomization of the irrigators' associations which have very severe repercussions on the management of the irrigation systems as a whole: the functions of "water police" and works maintenance are endangered by recurrent conflicts.

External interventions, whether they are public or private, affect only limited groups and do not take into account all the users and systems as a whole.

These phenomena are quite serious, for the maintenance of traditional networks largely rests on a very strong social cohesiveness among the users.

If some of the groups find themselves affected by thefts of water, without any specific improvements, they will tend to refuse to participate in the collective works that aim at maintaining the canals. The conflicts could go so far as sabotaging the work then proceed to direct confrontations.

On the short and medium term, such an evolution could only culminate in an agricultural recession, the risk of running short of water leading the involved farmers to choose even more extensive production systems.

On the medium and long term, the major risk lies in the disappearance of certain systems because of a lack of regular maintenance.

In order to prevent such an evolution, it would seem appropriate to propose from outside some global rehabilitation projects on a ZARI as a whole and probably to reinforce the role played by the irrigator associations by organizing them in a federation so that they will become partners in the rehabilitation projects.

CONCLUSION

The franco-Ecuadorean team started first by identifying the many problems that are involved in, and explain to a large extent, the poor performances of traditional irrigation systems and then will carry out an in-depth survey of each problem area and attempt to provide data on the impact of the various dysfuncions that have been identified.

In a second phase, the team will set up a network improvement plan adapted to each type of ZARI, which should give maximum efficiency to the public financial assistance that is being provided for modernizing the Andean irrigation systems.

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