Hanan Sayoc Irrigation System, Quinua District, Peru

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1 Part I: Static Analysis - Collective action

The district of Quinua is an independent community where most of the lands are owned by individuals. The elevation of central town is slightly less than 3,396 meters and the population of the district is 5,348. Most of the people in Quinua are subsistence farmers. The district of Quinua is divided into two barrios because of two major drainage systems. The barrios are not upper and lower attitudinal division like in many other cases in parts of Andes. Hanan Sayoc is one of the two barrios of Quinua district in the Peruvian highlands. Lurin Sayoc is the another one. The irrigation system originates from the mountaintops and flows down to the fields. The key resources (natural infrastructure) in the Hanan Sayoc system are land (private) and rivers, streams, and rain water. In Hanan Sayoc, a cement damn is used to store water at the lake Yanaqucha Chica which is the water source of the system. The key resource relevant to the commons dilemma faced by the community is irrigation water (common-pool). Vertical division of field types allows for the allocation of water to where it is most needed. There are different principles of water distribution for dry season crops, rainy season crops, domestic use, and hydropower, but hydropower is only in Hanan Sayoc. Political officials legitimize customary altitude-based rules of water distribution (especially in those seasons when water is most needed), but do not create rules. In Hanan Sayoc, unlike Lurin Sayoc, there is an irrigation judge. Also, the elders and people who contribute to fiesta have first access to water. Water is otherwise informally distributed by the users.

This case was part of the original CPR database developed in the 1980s by Edella Schlager and Shui Yan Tang at Indiana University. This case study is part of the e original CPR database and the full report may be found under Institutional Analysis ¿ CPR.

1.1 The Commons Dilemma

- **Potential over appropriation / poor coordination of appropriation**. The common dilemma arises as the irrigation system managers in the Hanan Sayoc barrio only exist to legitimize customary altitude-based rules of water distribution. Managers and political authorities do not create or enforce any rules. However, there are local institutions (mostly norms) that monitors the water distribution. There are no specific rules to avoid over-appropriation of irrigation water. The informal institutions are poorly coordinated. The potential of over-appropriation is real as the people in power, elders, wealthy people who contribute to the fiesta, and the people who are located near the gate have prior access to the irrigation water. These people have the preference, but it is not clear how much water they can use which leads to the potential appropriation problem. There are no rules to avoid this appropriation dilemma. It is

trusted that users will not use more water than what is necessary to them. According to the original report, there is no documentation of users not respecting the norms. However, there is mentioning of disputes regarding water distribution and occasional water theft, but the main reasons are not mentioned.

The lack of law enforcement leads to water theft, water appropriation by wealthy and powerful residents outside customary altitude-based rules, and tension among individuals that lead to violence. However, it is reported that the fighting and arguments over the water distribution have increased after the end of the rural political organization(Varayoc). Because of the complex and unclear layers of authorities and acephalous nature of water distribution, it is rather hard to solve these conflicts. The problems leading to over appropriation of irrigation system seem to be a provision problem, a soft human-made infrastructure provision problem. Precisely, it is provisioning problem of sanctions. These social sanctions are limited to only water theft. There is not any information on how strictly they are enforced or how successful they are. Hence, the problem of legitimizing sanctions prevails.

- **Potential under-provision of public infrastructure**. The irrigation system is different in Lurin Sayoc and Hanan Sayoc. The hard human-made infrastructure in Hanan Sayoc is more advanced in that they have cement damns and the gates are made of metal whereas in Lurin Sayoc the canals and gates are made of earth. Whenever there is need for cleaning of canals or seepage problems, its up to the public to fix. They have ritual celebrations for cleaning and maintenance: Yarqa Aspiy (cleaning of the irrigation system) and Yarqa Ruway (working of the irrigation canals). In Lurin Sayoc, the cleaning ceremony was organized by the rural political organization. However, after the end of the rural political organization, the responsibility to organize ceremonies were undertaken by municipal authorities. In case of Hanan Sayoc, the municipal authorities were responsible for organizing the cleaning and maintaining ceremonies even when the rural political organization existed. All the families using the irrigation system must participate in the cleaning and maintenance of the irrigation system. The families failing to participate in the cleaning and maintenance of the system are subjected to pay a fine. The nature of the fine or the amount of the fine is not stated. The role of municipal organization may be more successful in avoiding the problem of free riding. It is not stated, but water appropriation dilemmas, in general, tend to lead to the under-provisioning of hard infrastructure.

1.2 Biophysical Context (IAD)

- **Natural infrastructure**. Quinua is a district located on the western slopes of the range of mountains forming the eastern wall of the Ayacucho valley. The region has two major seasons: the rainy season from September to October and the dry season from May to September. Moisture and temperature in the mountain gives rise to five different ecological zones in Quinua in which the socio-ecological system takes place. The highest zone, the alpine rain tundra/subalpine wet pramo (4,100+m), is above the level of agriculture, as it is very cold, moist, and cloudy. Below it lies the montane prairie (4,000-4,100 m), the moist forest (3,400- 4,000 m), the lower montane savanna (2,850- 3,400 m), and the lower montane thorn steppe (2,500-2,850 m). Agriculture is practiced in all ecological zones except in the highest zone. Each farmers turn to receive water depends on her/his location in the mountain. In addition to that,

the social status, their contribution to fiesta, religious and political contribution also determine their preference to irrigation water. Political, social, and economical status aside, the natural infrastructure does play a role in monitoring of water distribution because the families located close to the gate (located in higher altitude) get preference to the water. Since, there is no report on over-appropriation, it is hard to analyze if that system is effective or not. In situation like this, the monitoring is prone to be more effective if the users are considerate of other users down the stream and do not over exploit the resources. The author mentions that the resource (water) seems to be limited, but the parsimonious use of the limited water resource is impressive in the Quinua irrigation system. However, the credit for the effective parsimonious use of limited resource can be attributed to soft human-made infrastructure more than the natural infrastructure and/or hard human-made infrastructure.

Normally, the characteristic of upstream - downstream regions may generate conflict among users, but in this case, because of the different climate between both regions, users are not uncomfortable with the difference in water distribution between them. However, there are still conflicts regarding water distribution. It is not clear the nature or the reason of conflicts. It would be more useful to know the nature and reason of conflicts for better institutional analysis.

- **Human-made infrastructure**. The appropriated resource, water for irrigation, originates at the alpine rain tundra/subalpine wet pramo, and is captured by the Hanan Sayoc canal system. Irrigation canals vary in size between 25 and 85 cm wide and 25 and 100 cm deep. This irrigation system is controlled by a simple system of gates and cement dams used to divert water to canals or store water at Lake Yanaqucha Chica. However, the irrigation canals and reservoirs are primarily made of earth. The use of cement is occasional. Consequently, seepage is a major problem. In Hanan Sayoc, because of lack of natural springs, the irrigation canals are modified to provide potable water to households and power electric generations. There are cisterns which are connected to the system to provide water for households that are outside the central town. This modification of the system took place only a decade before this project took place.

1.3 Attributes of the Community (IAD)

- **Social Infrastructure**. Quinua is a district of approximately 5,348 people, predominately Quechua speakers. Majority of the population are subsistence farmers that practice agriculture in multiple ecological levels in the mountain. The district consists of a central town surrounded by rural organized hamlets and dispersed settlements. It is also divided into two barrios: Lurin Sayoc and Hanan Sayoc, each with their own irrigation system. In Hanan Sayoc, water allocation is determined by an irrigation judge every Sunday during the rainy season, and water allocation is based on the altitudinal five locations of farmers in the mountain. Once users receive access to the irrigation system, they are responsible for changing gates, storing water in the reservoir, and avoiding water theft during their turn. Users are required to participate in the cleaning and maintaining of the canals during irrigation festivals which are held simultaneously at the end of August. Membership and participation in the barrio is determined by residence and not based on rules of descent.

- **Human Infrastructure**. There is not enough information to infer about human

infrastructure. However, it cannot be denied that the soft-human made infrastructures regarding the distribution of irrigation water is quite impressive in Quinua region. This can and should be attributed to the skilled and disciplined residents of Quinua. Also, the credit is due to the people of Quinua region for maintaining and sustaining a system that has worked for generations. There are conflicts among users and occasional water theft incidents, but the overall system is quite effective. This is possible because of the human infrastructure, the ability of the people in Quinua to make the system work despite poor coordination of the rules (formal or informal). There is no mention of the basic educational level or the communitys educational attainment or whether they are highly skilled farmers, but the system is quite effective and that is a characteristic of human capital.

1.4 Rules in Use (IAD)

As aforementioned, the overall distribution of irrigation water in Quinua seems to be effective in that the system meets the various needs of the residents. The vertical division of field is successful in allocating water where it is most needed. The different principles of water distribution for various types of crops (dry season and wet season crops) in the region have been proved to be efficient in meeting the water needs for different seasons. The effectiveness of the water distribution system in the Quinua region can be attributed to the soft human-made infrastructure rather than the natural infrastructures or hard human-made infrastructure.

1. Position Rules:
    - Water management/ Distribution
        - An irrigation judge is responsible for the distribution of water during the rainy and scarcity season.
        - Outside the rainy season, barrio residents allocate water individually.
    - Due to variation in the altitudinal levels in the mountain, farmers above 3,400m are considered upper savanna farmers while those below the 3,050 m are considered lower savannah farmers.
    - On Sundays priority is given to: cisterns holder, hosts of fiestas and elder residents who have fulfilled several religious and political obligations.
2. Boundary Rules:
    - Water from the Hanan Sayoc irrigation system can only be accessed by Hanan Sayoc barrio residents.
    - Only people that work in the cleaning of the irrigation system and those who contribute in maintenance of the canals can request water.
3. Choice Rules:
    - Each family using the system must provide a worker to clean the irrigation system, maintain the canals or pay a fine.
    - There are no specific monitors. It is the individual familys responsibility to change the gates, store water in the reservoir, and prevent water theft during

the time the family is given access to the irrigation system. Usually a member of family is assigned the duty to monitor the water. So, in this case, the users are the monitors and the monitors are the users.

- Farmers that have dry season crops, may irrigate on Sundays at the start of the rainy season.
- Throughout the year, Sunday is a free day. It is never assigned to a single person for his fields, but can be used by anyone on a first-come, first served basis.
- Older people do not need to wait for their turn to get access to water, though they may take water out of turn only once.
- People who contribute to fiesta also have first access to water.
- Political power takes precedence over rules of water distribution and the people in power can use water whenever they want. It is not clear, how that power is defined.
- At times of water scarcity, the formal distribution may be re-instituted at any time of the year.
- Distribution of irrigation water returns to the informal first come, first serve methods of the dry season cycle, although, if water is limited, people may give it first to the hamlet with the greatest need.

4. Aggregation Rules:

   - An irrigation judge decides every Sunday who receives water based on altitudinal needs and work on cleaning the irrigation system. This is different in the case of Lurin Hayoc as there is no irrigation judge.

5. Payoffs Rules:

   - A person who has not worked in the cleaning of irrigation ditches or contributed in maintenance has to pay a fine in order to receive water. There is no determined punishment or formal sanction in case of water theft. It is up to the individual family to control water theft. It is not clear what the consequences of stealing water are. It seems to be more of a social shame than any definitive punishment.

6. Scope Rules:

   - There is no information on scope rules in the original case study. If there is, then it is really hard to determine because the outcome in this case is not clear.

7. Information Rules:

   - There is no information on information rules in the original case study. The author mentions that the patterns of irrigation structure represents the Ancient Andean structure. So, the existing system could be a byproduct of the indigenous knowledge/information.

1.5 Summary

Water distribution in Hanan Sayoc is informal during the dry season. It is a first-come, first-served basis and formal during the rainy season, in which an irrigation judge distributes the water based on the altitude needs. Once water has been distributed, it is the individuals responsibility to change the canals gates, store water in the reservoir, and prevent water theft. However, the common dilemma arises as water is indiscriminately appropriated by powerful townsmen and occasionally stolen; factors that hinder water availability of an already limited resource. There is no clear indication on whether the author sees this as a successful system, but the indication is that this system seems to be effective in this region. One of the reason could be the flexible adaptive institutional arrangements.

2 Part II. Dynamic Analysis - Robustness

The follow up of the Hanan Sayoc Irrigation system study was made in 2013 by Na- talia Rodriguez at Arizona State University. The update is based on Mitchell (1994) who described the socio- economic changes that have taken place in the town of Quinua.

2.1 Shocks, Capacities, Vulnerabilities

By 1994 the town of Quinua a combination of socio-economic pressures had reduced farming practices in the Ayacucho Valley, and therefore, the town of Quinua.

Yanaqucha Dam (link 7 to PI)

The desire to stabilize the water supply to the hydroelectric plant and potable water system for the central town of Quinua embarked on a project to expand the Hanan Sayoc irrigation system. Expansion of the system was achieved by constructing a new dam at Lake Yanaqucha. The project started on 1967 with federal funds and Corve labor. Although the project was finalized, budgetary constraints limited its size, and it was the principal contributor for the decrease of Corve labor in the town.

Changes in Corve Labor (link 8 to PIP)

Corve labors have been used in the past by local authorities to repair the general infrastructure: irrigation canals, reservoirs, roads, bridges, public buildings, schools, the plaza, chapels, etc. Corve labor is tax obligation of the conjugal family, and each family has to supply a male worker or pay fine. A decrease in Corve labor in Quinua started with the opposition of Lurin Sayoc residents to work on the irrigation expansion project in the Hanan Sayoc barrio. Stating the lack of benefits of this project to their barrio Lurin Sayoc residents contested the project, and also complained about the penalty system set in place for missing a day of work ($ 1.00 per day missed) and demanded to get paid. This latter demand resulted in a shift in social values since the Corve labor practice was in essence a non-paid activity directed by the community to provide infrastructure for the community. Henceforth, the Yanaqucha project was finished by Hanan Sayoc residents who received food for peace parcels. However, the latter incentive did not mitigate the discomfort of the Hanan Sayoc residents who believed that only the residents of the central town would truly benefit from the project.

Population Growth (link 8 to RU)

A rapid population growth of the town, supported by reduced infant mortality resulted in deep pressures on production and water scarcity. The doubling of the central town population put and extra pres- sure on the irrigation system which provide provided agricultural as well as drinking water. Therefore, the water available for farming was diminished and consequently the rainy-season sowing had to be delayed by two weeks in Hanan Sayoc in 1987.

Market (link 8 to RU)

Decrease of farming practices was also influenced by the declined in farm products values due to subsidies to the import sector, on products such as grains for the US. Therefore, low urban food prices resulted in a dropped of sierra products values and a reduction of farm income. The combination of these socio- economic factors have lead Quinuenos men to migrate alone while their families stay in the town (wives and children), or migrate with the whole family to the coast looking 9 for better income opportunities. Quinuenos that refused to leave the valley have diversified their income by engaging in non-farming jobs such as artisans, truckers, and petty entrepreneurs of all sorts.

2.2 Robustness Summary

Based on the literature the Hanan Sayoc irrigation system seems to have lacked high levels of robustness in the past, which influenced the farming status of the Barrio in the 1990s. According to the Mitchell (1994), a combination of multiple factors as described above, influenced the massive abandonment of irrigated agriculture in the Hanan Sayoc Barrio. By the 1960s resource users had decided to devote more time and energy to non-farm activities, they engaged in activities such as craft manufacture, petty trade, and highway repair, which decreased farming in the Quinua district. In addition, non-farm work and migration created serious labor shortages that clearly affected irrigated agriculture. Consequently, farming has increasingly become supplemental to the total household income, rather than being the primary source of income as in the past. This change of values was recorded in Mitchell (1994), where he explains that Quinuenos focus was more on the construction of schools, the infrastructure for their new commercial roles, rather than irrigation, the infrastructure of farming.

Therefore, despite its importance to farming, irrigation is not a priority anymore in the district of Quinua, and consequently Hanan Sayoc. However, there is not much information on the current farming practices in the region, or the management of the irrigation system. We can only speculate that there are still active farmers in the barrio growing crops either for household consumption or the market, and the management rules of the irrigation system are still in place; but take into consideration the reduction of water allocated for agriculture as it competes with drinking water.

3 Case Contributors

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