

Article

Water Institutions and Management in Cape Verde

Miguel Suarez Bosa

Facultad de Ciencias Económicas y Empresariales Edificio Antiguo de Empresariales, Universidad de Las Palmas de Gran Canaria, Despacho nº 15, Campus de Tafira, Las Palmas de Gran Canaria 35003, Spain; E-Mail: miguel.suarezbosa@dch.ulpgc.es; Tel.: +34-928-354-622; Fax: +34-928-451-829

Academic Editor: Miklas Scholz

Received: 30 March 2015 / Accepted: 20 May 2015 / Published: 29 May 2015

Abstract: The water-management model used in Cape Verde for irrigation water is a singular one involving both public and private institutions. The institutional framework adopted since independence (1975) includes influences of both Portuguese colonial occupation and African culture. Water is a *common-pool resource*, which can take the form of communal, private or state property, or not be subject to any form of ownership. Thus, this case study enables us to compare theories about managing. From a neo-liberal point of view, the common administration of resources of this kind is inefficient, but for one school of the institutional theory, solutions can come “from within”; in other words, from user groups themselves, who can co-operate, once they have defined commitments. Research based on surveys and interviews with private sector administrators leads to the conclusion that user association management is successful, whereas, individual management can lead to squandering.

Keywords: institutions; evolution; management; technology; water

1. Introduction

This paper analyzes the irrigation water management model in Cape Verde, an archipelago of volcanic origin. The Cape Verde constitution declares waters, in all its forms, the property of the State and the common heritage of the people. An irrigation-water management model has been created in these islands, which is typical of a semi-arid climate, similar to that of other Macaronesian island chains, an area which gathers the archipelagos of Madeira, Canary Islands and Cape Verde and also a small continental territory situated next Agadir (Morocco), and arid areas in several parts of the world.

However, some of the peculiarities of the Cape Verde model deserve closer attention. The main one is the co-existence of public and private institutions. The private management of a common resource (*res commnis*) predominates in managing the water from the *nascentes* or springs, whereas in the case of the *furos* or large wells, although the water belongs to the state, it comes under community management in most cases. The State, however, has been the “*maître d’oeuvre*” in handling water resources [1], even when the water catchment infrastructure is run by private individuals or producer associations, but it has had, and continues to have problems imposing its authority, as institutional legality exists side-by-side with tradition, totally allergic to control of any kind.

The model has evolved historically as the result of both colonial legacy and influences from the culture of mainland Africa, plus the stamp put on the system by the fact that it covers an archipelago comprised of 10 inhabited islands with major differences between them. The general forms of using the water are well-known, but it is worth contrasting them and interpreting them in accordance with characteristic theoretical water-management models.

Water is a *common-pool resource* (CPR), which can adopt the communal, private or state form of ownership, or it can be free from any kind of ownership. Its management as a community-owned resource in arid or semi-arid areas is well known in a range of areas such as the southeast of Spain, the Canary Islands, Maghreb, Southern California, Southern India or Latin America [2–8], but the administration options differ. The conventional model takes a pessimistic “tragic” view of communal administration [9,10], emphasizing the inefficiency of communal practices. Followers of part of the institutional school of thought, on the other hand [2], consider that the solutions for managing a resource of this kind can also come “from within”, from the user associations themselves who, under certain circumstances, are capable of co-operating. In other words, they can define credible commitments *a priori* and adapt them over time, to technological changes for example.

Hence, the institutional theory is considered valid for characterizing the irrigation water management model in Cape Verde. This theory analyzes the role of ownership rights and institutions in the structure and evolution of social formations. It is true that when it comes to managing an aquifer, there are difficulties in defining and enforcing property rights, as there are several institutional alternatives, although all of them are imperfect. Moreover, as the situations are the result of complex dynamics and form part of a social and cultural context, it is worth taking into account other theoretical and methodological contributions, such as analyzing the historic pathway or *path dependence* and the conditions of endogenous development or *embeddedness* [11].

The specialist literature defines the institutions, formal and informal, as the “game rules” or rules of socially-acceptable behavior that organize human interaction [12]. The problem arises when considering the role that the informal institutions have in economic and social life, bearing in mind that these are very frequent in Cape Verde society as they are not based so much on laws or explicit rules as they are on cultural traditions and beliefs that are difficult to classify. The introduction of new technologies, such as the technology used to drill wells or “*furos*”, for example, is also influenced by the institutional framework and, in turn, has an impact on ownership and distribution. On the other hand, ideology and politics have a decisive influence on managing natural resources. When it comes down to it, the environment determines how and when new irrigation technologies are used, as can be clearly seen in the kind of farming practiced in Cape Verde since independence.

The methodology allows the objectives set to be addressed. The method followed consists of comparing the quantitative data (reports, statistics) with qualitative data (interviews), allowing for an analysis to be made of the situation and the management model to be interpreted, which is the basic objective. It is a question of recognizing the responsibility of the players who have an impact on the present and future of water resources in Cape Verde. From this, it can be deduced that decentralization and community participation is feasible and advisable, according to concepts like sustainable and integral water management, solidarity and the new water ethic. The objective of a sustainable development policy is to decentralize management to local, popular groups, harnessing the support of private or para-public players and reformulating the role of the State, insofar as the State must take on basic global functions, such as monitoring and maintenance of water resources. It is worth remembering that, unlike in northern countries, these principles are important in developing countries like those of the Sahel, arid countries that suffer frequent droughts.

The content of this paper is as follows. The Section 1 presents the introduction and establishes the theoretical framework. The Section 2 explains the Materials and Methods. The Section 3 deals with most significant traits of water resources in Cape Verde: an analysis of the institutional framework and the water management institutions, formal and informal, are characterized; it also describes customary water use practises. Finally, conclusions are drawn.

2. Materials and Methods

Our case draws on many different sources on information: existing literature, official documents (laws, plans, cooperation programs, *etc.*), personal and semi-structured interviews with institutional managers designed for the occasion, and qualitative surveys directors of water-rights associations and communities, and documents and report made within the framework of the agrarian reform and placed in the History Archive of Cape Verde (not classified).

The starting point of the research method followed was an exhaustive analysis of the legislation and administrative documentation on water management. Next, gathering information by using guided qualitative surveys of the stakeholders involved, surveying institutional technicians and senior managers, directors of water-rights associations and communities, all of which are listed in the Appendix. These interviews were conducted on the islands of Santa Antão, Santiago and Fogo.

Censuses and empirical studies are available, conducted as part of international co-operation programs, such as the one carried out by French consultant *Bureau de “Recherches Geologiques Appliquees”* [13], the United Nations Program for Development (PNUD) [14], the “*Estudo sobre o desenvolvimento da água subterrânea Ilha de Santiago*”, funded by JICA/Japanese Cooperation and executed by Kokusi Kogyo Co. Ltd. [15], or the study funded by USAID and analyzed by Langworthy y Fina [16]. Also, the Cape Verde government has made reports as the “*Recenseamento Geral de Agricultura*” (MAAP) [17], funded by the FAO; or the “*Plano de Ação Nacional for the Gestão Integrada dos Recursos Hídricos*” [18]. Specific anthropological, economic and geographic studies are available, but most of them are local studies.

3. Results and Discussion

3.1. A Scarce Resource for Traditional Agrarian Structures

There are hardly any permanent watercourses in Cape Verde, with the exception of Santo Antão, where springs provide an appreciable flow all year round. Weather and geo-morphological conditions mean that most of the watercourses in the valleys only run with water during the rainy season. Rainfall varies, depending on the topography and latitude of each island (see Figure 1), so rainfall is very uneven, varying from the $475.40 \text{ mm}\cdot\text{year}^{-1}$ that falls in Fogo to the $46.90 \text{ mm}\cdot\text{year}^{-1}$ that falls on the island of Sal (data from the National Meteorological and Geo-physics Institute). Furthermore, the rains are highly irregular in both space and time; *i.e.*, from one year to the next and from one time of year to another, and they come in the form of downpours, such that some towns have all their rainfall in 2 or 3 episodes of torrential rain that cause significant damage to infrastructure and farming.

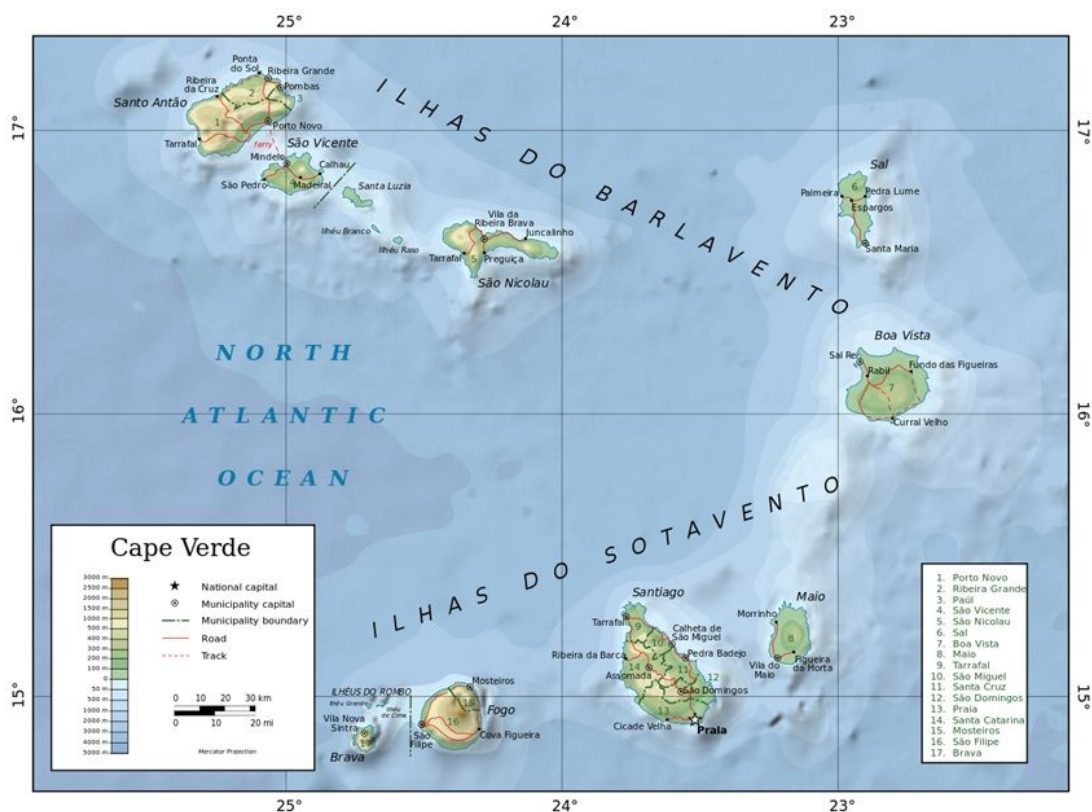


Figure 1. Situation of the Cape Verde Archipelago. Source: Adapted from Wikimedia Commons [19].

It has to be remembered that droughts are frequent in Cape Verde (Tables 1 and 2). The severest of the most recent episodes was the drought of 1970, which is considered the year the current cycle started. Rigorous studies indicate that there is a decline in rainfall of about 3% [20]. So this is a country that is vulnerable to both natural phenomena, particularly droughts, and the activities of Man, which leads to a modification of microclimates, desertification, torrential rains and volcanic eruptions like the one recorded this year (2015) on the island of Fogo.

Table 1. Physical characteristics and rainfall in Cape Verde (averages).

Island	Area (km ²)	Altitude (m)	Rainfall (mm/year) (Average 1990–1998)	Rainfall (mm/year) (2004)	Average (1990–1998)	Arable land (Ha)
Santo Antão	785	1,979	263	36,760	237	8,800
San Vicente	230	750	79	82.79	93	450
San Nicolau	347	1,312	164	199.40	142	2,000
Sal	221	406	--	46.90	60	220
Boa Vista	628	387	77	57.06	68	500
Maio	275	437	84	139.00	150	660
Santiago	1,007	1,394	234	297.50	321	21,500
Fogo	460	2,829	344	475.40	495	5,900
Brava	63	776	191	201.20	268	1,060

Note: Source: The author from CNA [20] PAGIRE [18].

Table 2. Estimated Surface and subterranean waters (in millions of m³/year).

Island	Surface Waters	Subterranean Waters		
	PNUD [14]	BURGEAP [13]	UNDP [14]	Master Plan
Santo Antão	97.0	29.2	54.0	28.6
San Vicente	2.0	0.3	1.0	0.6
San Nicolau	14.0	4.3	9.0	4.2
Sal	2.0	0.1	1.0	0.4
Boa Vista	6.0	0.4	5.0	1.6
Maio	4.0	1.1	3.0	2.1
Santiago	108.0	21.9	55.0	42.4
Fogo	87.0	21.9	42.0	42.0
Brava	8.0	1.64	5.0	1.9
Total	328.0	80.84	173.0	124.0

Note: Source: the author from CNA [20].

The use of surface waters on these islands is constrained by the high run-off, between 20% and 53% of the rainfall is lost, more than the loss from evaporation [18], so there is little catchment or storing. Most of the water used in Cape Verde agriculture comes from subterranean waters. Much of the 99,409 m³·day⁻¹ flow tapped comes from nearly 2304 springs, including galleries. Somewhat less comes from the 1173 wells or the 238 “*furos*”, larger-sized wells, going down to a depth of between 50 and 120 m and with a diameter of 30 cm [14].

The practice of using modern techniques to store water is a recent one in Cape Verde. Dams are concentrated on the islands of Santiago and Santo Antão, with 15 and 64, respectively, while there are 1605 storage tanks. The public authorities have promoted and adapted traditional techniques for transporting and distributing water, and for storing it in *reservorios* (tanks or ponds), such as *levadas* (channels built on top of, or excavated into the rock, which direct water using artesian methods), which has made it possible to increase the area of irrigated land [1,16]. New infrastructure has been constructed in recent years, including the Poilão reservoir. Strong pressure on water resources is the root cause of the proliferation of wells, causing over exploitation and placing constraints on the development of irrigated areas, especially in the coastal areas, with considerable potential for irrigation availability, by the following sources.

In a services-oriented economy (86% of GDP in 2007), the agricultural sector contributes between 6.3% in 2004 and 5% in 2007, according to the National Statistics Institute. However, the sector generates around 45% of employment [18]. Agricultural structures vary enormously. There is direct production (independent farmers) and indirect production (in different forms such as share-croppers, lease, *etc.*), irrigated land, non-irrigated land and mixed systems. The latter are perhaps the most characteristic of Cape Verde agriculture and they are to be found on most farms, especially the large ones.

Despite its small size (*sequeiro*, or non-irrigated land, account for 93% of the arable land), consumption by the farming sector accounts for around 50% of the waters under management; although the differences between islands and districts are considerable. The irrigated land has always been, and remains concentrated in the hands of a few. For example, on the island of Santiago, before independence, 48% of the irrigated land (which includes ownership of the water) was in the hands of 4% of the population. After Independence, however, some properties were distributed [1,21] and water was nationalized in the agrarian reform, although the process was reversed in later years.

Farms relying on rainfall (*sequeiro*) traditionally grow mainly maize as the preferred food crop and cultural symbol of the people of Cape Verde. This crop is often combined with pulses (beans) and tubers, forming a typical multi-crop holding with many possible combinations such as tubers-maize, maize-beans, *etc.* These dry-land farms usually keep some domestic animals, too, such as pigs, goats or cows, to supplement the farmer's diet.

Crops grown on irrigated land (*regadio*) are normally only irrigated irregularly. In this case, the predominant crops are, first and foremost, sugar cane, the oldest and most predominant crop. However, it is grown more for cultural reasons than financial ones, as it is the raw material for making *grogue*, the national drink; although it is true that it tolerates water shortages very well. On its own, or grown in combination with other crops, it occupies 76% of the irrigated land, but it is not exported. In second place are the tubers (potatoes, sweet potatoes and manioc), which are fundamental to the family diet in Cape Verde. Banana plantations, developed in the 20th century, are widespread and bananas can be found either on their own or grown in combination with other crops such as manioc or sugar cane. Pulses, generally grown in combination with one of the other crops mentioned, are essential for local consumption to supplement vegetables, such as carrots, cabbage, potatoes, onions, tomatoes, *etc.*

The Government has promoted the use of new technologies, subsidizing innovative methods (by paying for one-third the costs) in the use of water in agriculture, such as spray irrigation or drip irrigation; for all this it is often advised by international organizations like the PNUD [14]. However, in many cases they meet with opposition from peasants who prefer traditional techniques.

As far as drinking water supply is concerned, governments have made sterling efforts to provide the population with a good water supply. The cover is 93% in cities and 74% in rural areas, enabling the country to approach the Millennium Development Goals. The water supply may be in the form of the public water network (the most widespread in cities), tanks or cisterns (widespread in the countryside). In both cases, the origin of the water can be subterranean or industrial, with desalinated water produced on practically all the islands.

There are currently five operators who provide desalinated water for the population and industry. In the main towns and cities, the water is produced and distributed by ELECTRA (National Electricity Company, Praia, Cape Verde, with a production of around 14.850 m³ a day) [18], a private-public partnership that also generates and supplies electricity. Elsewhere, water production and distribution is

mainly guaranteed by autonomous municipal services. There are also small, private operators that run seawater desalination systems and some wells, which supply and supplement the water distribution network.

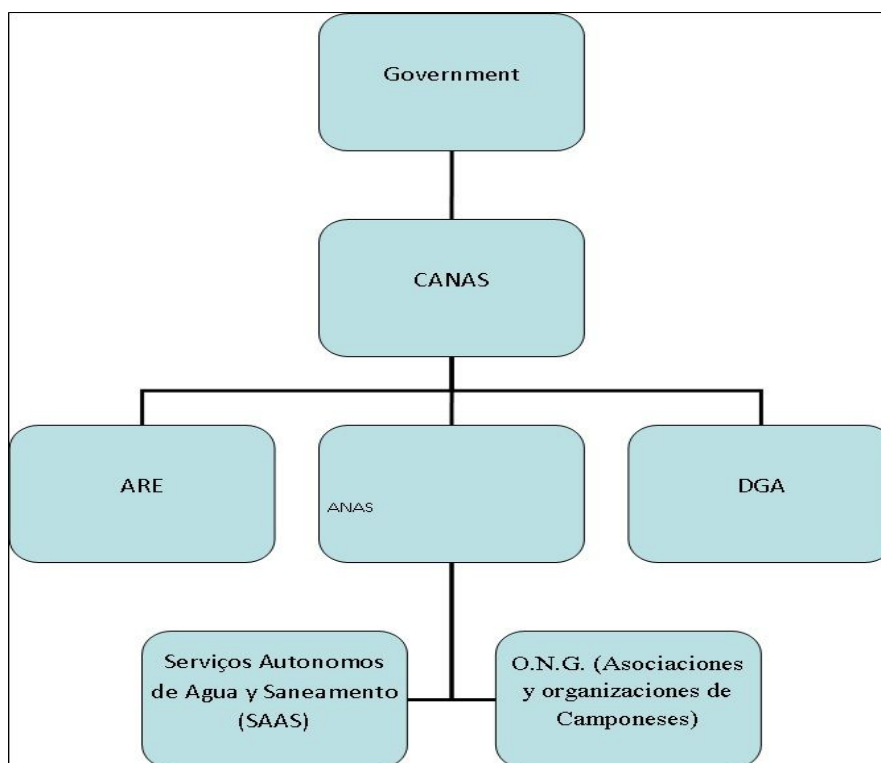
Several studies suggest that the domestic water supply is largely the responsibility of women. In isolated rural areas, especially, women are responsible for carrying water from the source to the home, often involving a journey of four or five kilometers. These are the *apanhadeiras*, who carry 20 liters or more of water on their heads at a time, causing them health problems. The Government is trying to solve this situation [22].

3.2. *The Role of the State in Water Management*

The way water resources are controlled and valued in Cape Verde is part of a long tradition. Productive resources are governed by a network of superimposed private and public institutions. The daily management of irrigation networks is done directly by the farmers, official bodies or by way of mutual-help arrangements or informal institutions, through which families can exchange favors with neighbors, as happens with all other farm work. This intersection of different institutional levels can be complementary.

Since Independence (1975), successive Cape Verde governments have promulgated a raft of laws on water management. Portuguese colonial legislation, although it was repealed, has had a profound impact on later legislation. The old colonial Water Code, the principles of which were derived from Roman Law and the Civil Code [23], consecrated private ownership of water. Later on, although the intention of the Cape Verde government was to break away from the colonial view and individualist principles to facilitate access to ownership for small farmers and share-croppers, first of all as “*pos útil*” and later as “*pos plena*”, private individuals were also allowed to drill wells in special, duly justified cases, where the water was to be used for farming.

The institutional model has gradually consolidated since independence (1975). The first *Código de Água* (1984) gave water management to the *Junta dos Recursos Hídricos* (JRC); it was founded by the *Instituto Nacional de Gestão de Recursos Hídricos* (National Water Resource Management Institute) (1992) (INGRH, as it is known in Portuguese), whose plan, develop and protect water resources. The new Water Code contemplates the principle of the public domain of water resources and water-related works, although a later review (1999) gave rise to private initiative. The most significant bodies that have been set up in the process are the *Conselho Nacional de Aguas* (National Water Council) (CNAG); while the *Agencia de Regulação Económica* (Economic Regulation Agency) (ARE) (2003) is an administrative institution with regulatory, oversight and sanctioning powers that promotes social cohesion and protects consumer interests and rights; the *Direção Nacional do Ambiente* (National Environment Directorate, DGA) has environmental regulation functions. Finally, since 2013, the INGRH has given way to the *Agência Nacional da Água e do Saneamento* (National Water and Sanitation Agency) (ANAS), answerable to the *Conselho Nacional da Água e do Saneamento* (National Water and Sanitation Council) (CANAS). (See Scheme 1).



Scheme 1. Institutionalization of water administration in Cape Verde. Source: Adapted from Borges [24]. Made on the premises.

Non-governmental organizations and community associations, on the other hand, make up what is known as the N.G.O. Platform, which participates in development programs, along with the “*organizações de camponeses*”—farmers’ organizations—particularly where there is traditional irrigation farming, taking part on a different scale in all stages of the water supply and sanitation projects [18].

The Municipal Water and Sanitation Services (SAAS in Cape Verde) manage water production. They normally operate supply systems made up of a “*furo*”, or large wells, with an electric pump or diesel generator, linked to a tank or pool (*reservorio*), from where the water is distributed to the population through distribution points (*chafariz*) or small home networks. These bodies face several problems arising from a confusing pricing policy and lack of co-ordination, as the tariffs are approved by the *Câmaras Municipais* and other similar entities, but the criteria they use are far from clear. What is true, is that as an incentive for introducing technology, water is supplied at subsidized prices, which seems to be a good decision. This policy benefits farms that use water-saving technology, such as drip irrigation. On the other hand, water from gravitational systems (*nascentes*, galleries and others) or from private wells do not pay any tariff at all.

Thus, the State has been and remains the “*maitre d’oeuvre*” in handling water resources in Cape Verde [1]. Although the water catchment infrastructures are run by private individuals or producer associations, the legal owners of the *furos* and most of the pumping equipment is the State. In these cases, the government has left the management in the hands of the “*Comissoes de Água*” (Water Committees), with a government delegate on them from the *Ministério de Desenvolvimento Rural* (Rural Development Ministry). Then the “*Comissoes de Moradores*” (Neighborhood Committees)

have been given the authority to regulate the operation of the streams and springs. It has fostered the participation of farmers and social groups, perhaps in a ritual nod to their African heritage, giving the leading role to local and community agencies, some of which are run by the local councils and others are not. Reality, however, reveals that water management in the hands of these bodies has not always been conducted in line with a system of granting licenses to run a concession [18], with clear cases of lack of control coming to light.

In short, the Cape Verde state takes measures to decentralize irrigation management and governance. This policy has given greater responsibility to municipal authorities and it has also stimulated the participation of the local population through communities. So the trend is as follows: (a) to affirm the municipal services as managers of water services; (b) partial privatization; and (c) and in rural areas, the development of community-type management structures.

3.3. Formal and Informal Institutions: Associations

As we have already said, water management in some countryside areas of Cape Verde has much in common with other territories with an arid climate, be they island or mainland territories. It is true that the difficulties of access and storage place constraints on water stakeholders, although the uncertainty is tempered by technological developments. It is hardly surprising that communal solidarity in the use of water is similar to what can be seen in some areas of the semi-arid mainland Sahel, showing that the form of management is clearly influenced, not only by the availability of water, but also by the socio-cultural context in question (embeddedness). In the case in question, solidarity arises from the extensive family relations and neighborliness.

But, in Cape Verde, water distribution varies depending on whether it is obtained naturally from *nascentes* or tapped by opening wells or galleries. Even if the State intended to centralize the management and administration of water resources, the owners of the *nacentes* still consider the water as private property, and they look after its management themselves, by means of informal arrangements with private individuals. This water, generally used in farming, is tied to ownership of the land, in accordance with the system inherited from colonial times, without any substantial modification since independence. Hence, it is controlled and managed within a scheme of private ownership, and distribution is made through agreements and arrangements between the farmers who own it. However, these have been unable to organize efficient institutions, such as those in the Canary Islands, to quote a nearby [4,5,25].

In this case, the farmers manage the waters through an individualist system of sharing out the resources. Users' Associations scarcely exist, or have only recently been set up, ignoring to a large extent the recommendations of the co-operations programs, such as, for instance, the one rolled out by a U.S. mission in the Paul Valley [16]. The comparison with other territories is unfavorable: in the Canary Islands, for example, the system of *Heredades* and *Comunidades* is more efficient. They are private institutions that are nowadays admitted by the Administration [25]. In the Canary Islands, the systems of *Heredades o Comunidades de Agua* are in the origin of the associations of owner of water for agriculture. Due to a management that represents the community of proprietors, they are capable of having a structure in order to implement projects, to arbitrate and to negotiate. On the contrary, in Cape Verde, there is no real organization of water management. The State has come across the

resistance of the former owners and, although it has made a dedicated effort to promote programs to modify the way water resources are managed and how domestic water is controlled, few people pay it much respect.

Thus, individualism is the norm, especially in Santa Antão and the other windward islands, as farmers are very reluctant to give up their water easily, even if they have more than they need, they would rather flood their lands, following the principle of “*quanto mais agua, melhor*” (the more water the better), as is frequently heard in the Cape Verde countryside, leading to clearly adverse effects for the community and squandering of water [26].

The situation is different in the *furos* and wells. Most of this water is administered by local communities or farmers’ associations. It must be pointed out that the State has been more successful in this case: it has fostered community action, promoted the activity of communities and associations of *camponeses* and local bodies. Although informal practices persist, the result of the cultural influence of their African roots, such as *djunta-mó* [27,28], a form of helping one another in Cape Verde, an African legacy that literally means to get together and join hands in a common effort to achieve major objectives.

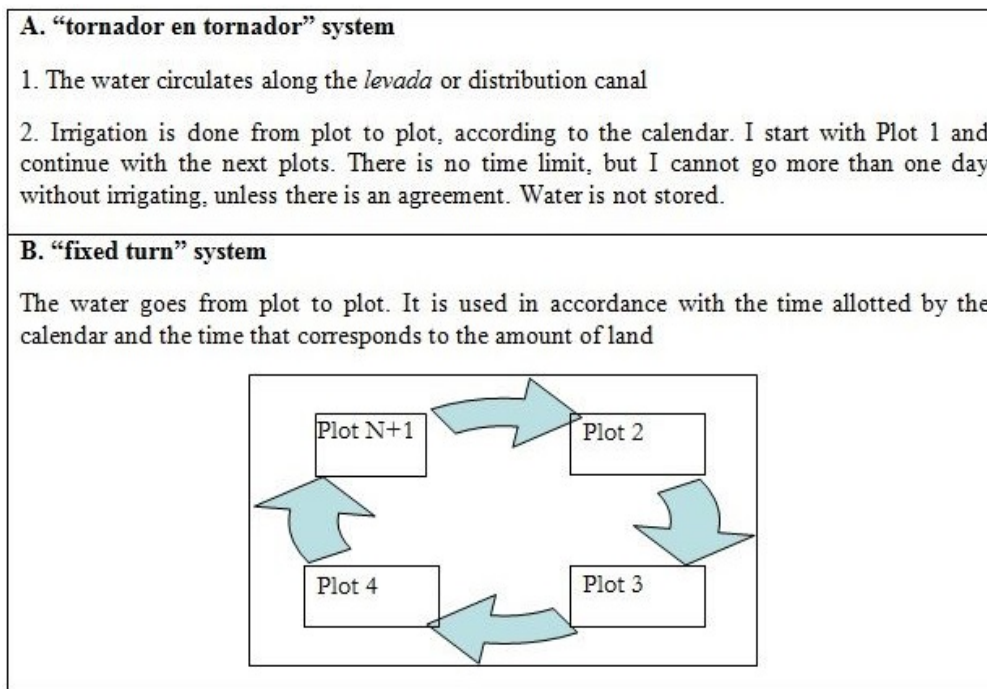
In customary management, growers re-interpret and adapt communal uses and the customs of helping one another, combining the irrigation *calendário* with the practice of *djunta-mo*, especially in Santiago and other leeward islands, where the Africa influence is greater. This custom of helping one another is also a response to the difficulties represented by the omnipresent physical environment, appearing in the form of downpours or cycles of drought that systematically destroy vital resources, frequently causing widespread destruction and major famine; hence, it is natural to encourage defensive strategies to preserve resources. To some extent, they adapt to the principles of water ethics with the community-management system, which, albeit somewhat idealized, does involve non-passive populations who are aware of both their rights and duties and of the lasting importance of water. Making local communities responsible in rural areas is a primordial issue for all poor countries with few resources, like Cape Verde.

3.4. Water Distribution Systems: The Calendar

In both kinds of practices, *i.e.*, whether the water comes from *furos* or from *nascentes*, irrigation water is distributed in accordance with the amount of land, albeit with slight variations depending on the tradition and the place in question. To organize this, a calendar is drawn up, whereby water is provided for a time, either by fixed rotations, with each neighbor receiving a specific number of hours, or each neighbor can use the water until he, or she, has flooded his/her land. It is a system that is similar to the *dulas*, or irrigation shifts, used in several places on the Spanish and Portuguese mainland, in the Canary Islands, in North Africa and in San Antonio, Texas, in this case as a legacy of the Canary Island emigrants that have settled there since the end of the 18th century, or in Mexico [6]. There are two systems: (a) “*tornador en tornador*”, irrigation is done from plot to plot, there is no time limit; and (b) “*fixe turs*”, the water is used with the time allotted (See Scheme 2).

Once established, the number of days is maintained as “use and custom”, passed down from one generation to another, hence establishing the amount of water there is in the hands of a given property. The calendar system is characterized by providing the water at times with a long interval between them: only 6% of the distribution has an interval of seven days or less. Fourteen percent on the other

hand, have an interval of 8 to 15 days, 71% from 15 to 30 days and 10% have an interval of over 30 days [14,27].



Scheme 2. Kind of calendar used for water distribution in Cape Verde. Source: Information provided by Paulina Costa Fortes and Manuel Baptista, Representative and Engineer from MRD/IHGRH, respectively in Porto Novo (Santo Antão) and the interview occurred in Porto Novo on 4 December 2013.

Traditionally, the “*meirinho*” is responsible for distributing the water in accordance with the “*Código de Posturas*” (as in Portugal, the documents that brought together a set of municipal by-laws throughout the public sector were originally known as a “*Código de Postura*”). In other words, in accordance with the number of hours each owner is entitled to. He or she is also responsible for levying sanctions and for enforcing the rulings of the Municipal Corporation or Local Board. The possibility of levying sanctions on transgressors is one of the necessary, but not sufficient, conditions for the community system to work properly and prevent the problem of “scroungers” [2].

When water is privately owned, the most frequent option chosen is to flood the “*tajos*” that the plot is divided into. This way, the water can be used on the land for a very long period of time [27]. There are obviously several problems with this method, particularly squandering resources. The most frequent crop grown is the one that best adapts to this system. This explains why they continue to grow sugar cane, although it requires a lot of water, according to interviewees, e.g., José Manuel Pires Ferreira, Chairman of the AmiPaul Association (interview the 6 December 2013), opinion corroborated in other interviews.

The water from most of the “*furos*” is distributed by the pump-man, or the civil servant who distributes the water according to the calendar. In this case, the most commonly-used way of distributing the water is access once a month for enough hours, depending on the land that the farmer

has in cultivation, but if his rightful share is more than he needs at that time, he can store it in a pond, or give it to someone else [16,26,27].

This water is often provided as a loan, or “*troca de agua*”, a system of helping each other that is similar to the *Djunta-mó* system. This is an agreement between owners, who consider that they are donating part of their right by giving their turn to someone else, which leads to sharing the water. One owner gives the surplus water that he owns to a neighbor and waters the neighbor’s lands on the days when it is the former’s turn to irrigate his, for instance, when the flow of water (*mae d’água*) is abundant, allowing the land to be irrigated in less time. Exchanges are frequent within the (extended) family, between brothers, uncles and nephews, *etc.*, and it is a practice that allows for a moderation or modulation of the calendar system.

4. Conclusions

With the information obtained from our informants in Santiago, Santo Antão and Fogo, whether they are institutions, associations or irrigation communities, a wide variation in management procedures can be seen. Although more exhaustive information would be advisable, basic lines for improving the management of irrigation networks can be suggested. Pursuant to the introduction, first of all, the importance of the institutional framework has been shown as a constraint on behavior in resource management. In Cape Verde, an institutional framework has been laid out that, in theory, guarantees ownership rights and regulates water management, but it is obvious that if these rights are not well defined, dysfunctions can be generated. Moreover, and although it is usually ignored, the role of the political process is important for implementing an appropriate institutional framework for the best use of water. However, individualist practices persist, such as flood irrigation, which can lead to squandering resources. As it has been said, path dependence process can be found in different unit of analysis individuals, organizations, institutions or technologies, each one having its particularities.

Second, the above is not an obstacle that prevents individuals from being able to draw up credible commitments, in certain circumstances, without resorting to any outside authority. This cooperation can even be propitiated by the government, as it does in managing the water from the “*furos*” and storage tanks. The historical adoption of formal and informal institutions, born within the society itself, has facilitated agreements on water management among stakeholders. Customary practices based on the traditional culture of helping each other are of great importance.

Programs to review irrigation management in Cape Verde have come up against the thorny issue of water ownership. In general, water is considered to be private and inalienable property by those who are lucky enough to have it, hindering efficient management. To understand the situation properly, it should be taken in the context of the complexity of rural society in Cape Verde. In some cases, the underlying motivation is a search for individual and family success, but in others, there is an evident impact of community ties in Cape Verde society, in the form of citizens getting together to promote or attain common objectives.

Finally, collective management of water is the norm and fostered by the government, going back to traditional practices. The introduction of water catchment technology (in prospecting for “*furos*” and wells) or irrigation technology (installing drip irrigation), frequently encouraged by the administration,

is accompanied by driving community management through the participation of local communities and associations. In this case, as the game rules are clear, water management is more efficient.

The government response based on dissemination and technical quality is a sound foundation for building sustainable water management, so putting an end to cases of anarchy in the countryside has become a challenge. Effective planning, combined with decentralized management at the municipal level, could be effective, albeit only if it respects agricultural and domestic needs. Both individuals and local communities must abide by the rules laid down by the public institutions, but it is true that institutional legality is often ignored.

On the other hand, efficient and effective management of water resources, adapted to needs and preserving ecosystems, is important for sustainable development. Given that agriculture occupies an important place in the Cape Verde economy, solving resource management problems is crucial due to the low and unstable productivity of agriculture and the rapid growth of the population that depends on them, as occurs in much of the Sahel region of Africa. So, although there are no universal answers or recipes for resolving the dilemma of rural Cape Verde, the current support for associations and water-efficient technologies provides a more optimistic scenario for food production.

Acknowledgments

The author gratefully acknowledges the constructive comments and suggestions from the anonymous reviewers.

This work has been partially supported by a The “«*Título Proyecto*»” (Oceánidas), was made in the context of the SEMACA (Senegal, Mauritania and Cape Verde), this co-cooperation project was funded by the European Union as part of the MAC Project, 2007–2013. It was implemented between January 2012 and December 2013. We are grateful to the *Centro Universitario de Cooperación Internacional* (CUCI) from the *Universidad de Las Palmas de Gran Canaria* (ULPGC) for their support.

Appendix

Census of the institutions where the interviews have been made.

A. Non-Government Associations

Asociación AGROCONVENTO y AGROVERDE (Cidade Velha, Santiago)

Asociación de agricultores, Pecuaria de Bassia Hidrográfica de Ribera Seca (Santiago)

Asociación de Agricultores de Lajedos (Santo Antão).

Asociación Voz Comunitaria Alta Mira (Santo Antao)

Asociación Amigos de Paul (Santo Antão).

Asociación de Agricultores de Ribeira da Cruz (Santo Antao).

Asociación de Desenvolvimento Comunitario de Cobao e Arrededores (Tarrafal de Monte Trigo, Santo Antão).

B. Government Institutions

Instituto Nacional de Investigación y Desenvolvimento Agrario (INIDA) (Santiago).

Instituto Nacional de Gestão e Recursos Hídricos (INGRH) (Santiago).

Delegación del Ministerio de Desenvolvimento (MRD). Delegación de Santo Antão (Porto Novo, Santo Antão).

Delegación Ministerio de Desenvolvimento Rural (MRD) (San Vicente, Mindelo).

Delegación Ministerio de Desenvolvimento Rural (MRD). (Fogo).

Conflicts of Interest

The author declares no conflict of interest.

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