Recent Changes in Small-scale Irrigation in Zambia: the Case of a Village in Chibombo District

Shiro Kodamaya
Graduate School of Social Sciences, Hitotsubashi University, Tokyo, Japan

Abstract

This paper aims to explore factors behind the development of small-scale irrigation in Zambia by tracing the experience of irrigation development among small-scale farmers in a village in central Zambia. The paper also seeks to contribute to a deeper understanding of the environmental implications of irrigation development.

Irrigation farming in the village studied began as traditional or informal irrigation, whereby vegetables were grown in dambo gardens with the use of bucket irrigation. By the early 1990s, vegetable production in dambo gardens had become an important source of income for many farmers in the village. The combination of rain-fed maize cultivation in upland fields and vegetable growing in dambo gardens provided farmers with relatively secure and diversified income sources. As economic declines and structural adjustment measures in the 1980s and 1990s adversely affected the livelihoods of urban dwellers, farming of the village came to be economically more attractive. Irrigated vegetable production in dambo gardens became more popular as an additional income generating activity after the mid-1990s when the agricultural marketing was liberalized. In the early 2000s, some farmers in the village shifted from bucket irrigation to treadle pump irrigation with the assistance of an NGO. The introduction of treadle pumps entailed new methods in irrigation agronomy such as the use of furrows and pipes, the cultivation of winter maize, and more intensive use of land. The second half of the 2000s is seeing another development in the use of irrigation technology, with some farmers introducing engine pumps and drip irrigation. As irrigation methods developed from bucket irrigation to treadle pump and engine pump irrigation, water consumption level of each farmer likely increased.

The typical farming system found in the study area, which comprises the two practices is an expression of farmer adaptations in the face of uncertainties both in rainfall and market conditions. Introduction of new irrigation practices by some farmers can be considered as an expansion of the dambo gardening component of the system.

The development interventions by NGOs played an important role in the adoption and diffusion of new irrigation technologies. Support from NGOs related to irrigation development placed greater emphasis on income generation and market sales. The villagers continuously invested in new agricultural management practices and land-care techniques. However, the investments and technology promoted are mainly associated with income-generating activities, which may undermine the capacity of ecosystems to produce services. The case of the village studied demonstrates that responses of the farmers were not necessarily unified, coordinated responses of the “community”. The responses to the new farming practices and NGO support

mainly occurred at the level of individual farmers and farmers groups. As irrigation methods shifted to those entailing more capital intensive technology such as engine pumps, farmers' responses to new opportunities depended increasingly on their resource or capital base including social capital.

The shift from bucket irrigation to treadle pump and engine pump irrigation in the area has likely had a substantial impact on the use of water resources, especially groundwater. Since there are no customary or formal regulations on the use of groundwater, current opportunistic use of groundwater for irrigation can result in overuse of groundwater and might cause its decrease and depletion. It is crucial to introduce some mechanism of control and management of water resources which enables the sustainable use of this important resource.

1. Introduction

To achieve greater utilization of irrigation in a sustainable and environmentally sound manner is a great challenge for African[1] countries. This paper aims to explore the factors behind the development of small-scale irrigation in Zambia by tracing the experience of irrigation development among small-scale farmers in a village in central Zambia. The paper also seeks to contribute to a deeper understanding of the environmental implications of irrigation development.

Given the importance of small-scale irrigation in Africa's development agenda, it is important to identify factors contributing to the development of small-scale irrigation in current African contexts. Scholars and development practitioners advocate irrigation as an important means to achieve increased agricultural production and food security in Africa. In a region where droughts are prevalent, irrigation could be a key factor in enhancing food security. In the publication *African Environment Outlook*, it is argued that rapidly increasing the area under irrigation, especially small-scale irrigation, will provide farmers with opportunities to raise output on a sustainable basis (UNEP 2006: 84-5). Irrigation (mainly small-scale) is advocated as an example of "sustainable intensification" of agriculture in southern Africa, where agricultural growth depends on intensification rather than extensification (FFSSA 2004: 68). Thus irrigation is considered to be "sustainable" and contribute to poverty reduction among small farmers.

While irrigation can enhance food production, there are also risks such as its inappropriate application and overexploitation of water resources (UNEP 2006: 92, 136). Resource utilization becomes unsustainable when open access occurs in combination with demographic and technological changes (Haller & Merten 2008). Small-scale irrigation and cultivation of wetlands, without proper resource management, can cause land degradation or resource depletion. It is important to examine irrigation development in actual practice situations in order to determine how it can be kept sustainable and environmentally sound.

The adoption of irrigation practices exemplifies the coping strategies of small farmers who adapt and respond to new opportunities and constraints. We should examine the development of small-scale irrigation in terms of small farmers' wider strategies. The coping strategies of

[1] Unless otherwise noted, "Africa" refers to Sub-Saharan Africa.

individuals are integrated components of a country's wider economic system (Campbell 1990 cited in Zamani et al. 2006). Coping strategies are altered as a result of the emergence of new opportunities caused by a complex interplay of economic, political, social, and environmental conditions.

One issue to be investigated is how the actions of communities concerning small-scale irrigation development lead to sustainable practices which entail the management of socio-ecological systems. Fabricius et al. 2007 developed categories of communities according to their adaptive capacity and their role in ecosystem management. Communities are termed "Coping Actors" if they deal with adversity through reactive coping strategies. "Adaptive Co-manager" communities take a longer-term perspective in dealing with threats, and their adaptive strategies focus on sustainable management (Fabricius et al. 2007). While it is widely acknowledged that the concept of "community" is fraught with problems (Blaikie 2006), a community must be examined by focusing on its multiple interests and actors (Agrawal & Gibson 1999). This is because communities are composed of subgroups and individuals with varying preferences for resource use and distribution. It must also be recognized that human responses occur across different scales and levels of organization, playing out in multiple, uncoordinated, improvisational theaters (Bohensky & Lynam 2005).

2. Policy and Legal Contexts in Zambia

2.1. Politico-economic Setting

Over the last four decades, Zambia's political economy has undergone five distinct policy regimes (Thurlow & Wobst 2004):

(1) The period of a market economy and multi-party political system from Independence in 1964 to the early 1970s.

(2) The period of a state-controlled economy and single-party political system from the early 1970s to the mid-1980s. The government embarked on economic reforms to strengthen state control over the economy. Major industrial companies were nationalized, including copper mines. World copper prices plummeted in 1975 and this was the beginning of a 25-year stagnation of the Zambian economy. The political system also shifted to a one-party state.

(3) The period of economic transition in the second half of the 1980s. The government attempted to carry out IMF-World Bank-sponsored structural adjustment programs but abandoned them following political unrest.

(4) The return to a multi-party political system and the introduction of neo-liberal policies in the 1990s. After the 1991 multi-party election of President Chiluba, the MMD (Movement for Multi-party Democracy) government came to power. The government implemented economic liberalization and de-regulation policies such as the privatization of state enterprises, liberalization of agricultural markets, and trade liberalization. Economic stagnation continued with the deterioration of formal sector employment due to the economic liberalization.

(5) The period since 2001 of the "New Deal" under President Mwanawasa's government.

Economic liberalization policies were partly modified with more emphasis on poverty reduction. The economy recovered and grew, thanks to growing copper production after privatization in 2000, higher copper prices since 2004, and debt cancellations in 2005.

2.2. Policy and Institutional Setting for Irrigation and Water Resource Development

Zambian government policies and development plans emphasize the exploitation of water resources for irrigation development so as to achieve food security and poverty reduction. To reduce food shortages caused by the dependence of agriculture on rainfall, the expansion of irrigation is considered an appropriate solution. The PRSP (Poverty Reduction Strategy Paper) of 2002-2004 states the expectation that the expansion of irrigation would not only improve food security, but would also help reduce poverty[2] (Zambia 2002: 91). The Fifth National Development Plan (FNDP) sets a target of doubling the acreage under irrigation to 200,000 ha by 2010 (Zambia 2006: 49).

Zambia's policies and plans for agriculture and irrigation also have stressed the importance of the exploitation of water resources and irrigation development based on the recognition that the country is well-endowed with water resources, and on the assumption that irrigation is a sustainable agricultural practice. The 2004-2015 National Agricultural Policy provides 19 sectoral strategies including the promotion of sustainable and environmentally sound agricultural practices and the promotion of irrigation development. The National Irrigation Plan (NIP), formulated in 2005, proposes a strategy for efficient and sustainable exploitation of water resources by promoting irrigation. As interventions to improve the policy and legal environment, the NIP proposes the reduction of costs for energy and irrigation equipment as well as improved incentives for investing in irrigation[3]. The NIP recognizes the environmental considerations surrounding irrigation, stating that irrigation interventions do tend to generate an environmental impact. However, it also states, "there are no major worries concerning the effect of irrigation to the environment." (Zambia 2005: 10)

Government and donor policies are based on the recognition that Zambia is well-endowed with land and water resources which have been underutilized. Zambia is the most surface and groundwater resource-rich country in southern Africa (FFSSA n.d.: 47). The total internal renewable water resources (IRWR) have been calculated at 80 cubic km, while the total water withdrawal in 1994 was 1.7 cubic km.[4] Agriculture accounted for 77% of the total withdrawal, where the use of water is primarily for irrigation (Earth Trends 2003). Zambia's water sector is

---

[2] The perception that poverty is caused by the dependence on rain-fed agriculture is shared by Zambia's major donors. For instance, a paper by a joint initiative of major donors on pro-poor growth contends that crop production was negatively affected by the severe droughts of 1992 and 1995 which explain much of the increase in poverty that occurred between 1991 and 1996 (Thurlow & Wobst 2004: 31-32).

[3] It is recommended that during the first 2-3 years of the NIP, duty and VAT on basic irrigation equipment be reduced, and customs and excise duty for irrigation equipment also be reduced.

[4] 80 cubic km of surface water was produced internally and groundwater recharge was 47 cubic km. Total IRWR is: surface water + groundwater – overlap. There were 80 cubic km of overlap. The data was for 1977 to 2001 (FAO AQUASTAT cited in Earth Trends 2003).

undergoing an institutional transition[5]. While in 1994 the government adopted the National Water Policy (under revision since 2005), the national water sector framework is based on the old Water Act (1949). Presently the planning of water resources is fragmented. Plans for the development of agriculture, industry, and energy are prepared without adequate recognition of their impacts on water resources (Sievers 2006).

As of the mid-2000s, the total irrigated area in Zambia was officially 100,000 ha. Several estimates of irrigated acreage have been made. According to the PRSP 2002-2004, less than 40,000 ha of land is currently irrigated, mostly by commercial farmers (Zambia 2002: 53). The Water Rights survey (1994) estimated the total irrigated area at 53,000 ha, out of which smallholder irrigation accounted for only 210 ha (cited in FFSSA n.d.). However, these estimates did not include informal or traditional irrigation by small farmers, and if this had been included, the contribution of smallholder irrigation would be substantial. According to the Food and Agriculture Organization (FAO) of the United Nations, about 100,000 ha were estimated to be under so-called traditional irrigation in 1992[6]. These wetlands and dambos[7] in traditional areas of land tenure have been used for rice, fruit, and vegetable production without government intervention.[8]

There have been several programs promoting small-scale irrigation that were supported by the government, non-governmental organizations (NGOs) and donors. NGOs have played a particularly important role in mobilizing traditional farmers and emergent farmers to adopt irrigation practices. The Co-operative League of the United States of America (CLUSA) implemented a small-scale irrigation program through several NGOs including Total Land Care (TLC), World Vision International, and CARE. TLC[9], in collaboration with CLUSA, implemented a US$650,000 treadle pump irrigation project among 350 small-scale farmers (Daka 2006: 21). One NGO called International Development Enterprises (IDE) has been involved in the promotion of treadle pump and low-cost irrigation kits. Under USAID-funded projects promoting the Initiative to End Hunger in Africa, IDE was heading a market-led water management technology project called Smallholder Market Creation (Daka 2006: 21, 24, 27). As is clearly shown in this project, irrigation development is often associated with the commercialization of agriculture.

The ecological conditions of dambos and other wetlands are susceptible to deterioration, and the utilization of these wetlands for cultivation and irrigation may cause land degradation and depletion of resources. In Zambia, although it is government policy to promote the sustainable utilization of wetlands, there are no specific state laws that control or regulate such practices

---

[5] The author was not able to collect the latest information on the water sector. The paper is based on information from up to early 2006.

[6] Daka 2006 also shows an FAO AQUASTAT estimate for 2003: 155,912 ha of land in Zambia is irrigated, out of which an area of 100,000 ha is dambos used by small-scale farmers to grow vegetables.

[7] Dambos are low-lying, shallow wetlands. For an expanded definition and the types of dambos, see Shimada 1995: 3-4.

[8] FAO webpage on Zambia: http://www.fao.org/docrep/V8260B/V8260B1s.htm

[9] TLC is an international NGO based in Malawi, operating also in Zambia, Tanzania and Mozambique (Bayani 2008).

(Shimada 1995: 12).[10]

The water resource management sub-sector was in the process of reform in the early 2000s as some drawbacks had been identified, including: a poor water resource management, regulation and enforcement mechanism; and an inadequate institutional and legal framework (Zambia 2002: 94; Sievers 2006). Zambian water laws and policies exhibit pluralism (Chileshe et al. 2005); water rights follow a state law property rights system in urban areas whereas customary law is more prominent in rural areas. The Water Development Board under the Ministry of Energy and Water Development allocates water rights, although no water charges have been levied on any irrigation abstractions (Daka 2006: 24). The Water Board coordinates water rights at the national level, especially for large-scale users such as commercial farmers (Chileshe et al. 2005). The water rights provided in state laws do not apply to customary laws. Traditional authorities (chiefs and headmen) are not involved in water resource management at the national level. Local communities on their traditional land have their own rules and perceptions of water rights, which are closely related to their land tenure system.

3. Development of Small-scale Irrigation in a Village in Central Zambia

3.1. Agriculture in "Village C" in the 1990s

The study area is a village in Chibombo District of Zambia's Central Province[11]. The village studied (hereafter called "Village C") was established in the mid-1970s. The land where the village is located was previously covered with forest, and the area was gradually cleared for villages as people migrated in and settled in the area. Village C had around 120 households by the mid-1990s. It is located close to the tarmac road connecting Lusaka and Kabwe. The location of the village is good in terms of the accessibility of major urban centers; it is about 90 km from Lusaka, 40 km from Kabwe, and about 260 km from the Copperbelt towns. The agriculture of the village has benefited from its good location and the accessibility to urban markets, which is one of the factors enhancing the commercialization of agriculture. The village is located in a Trust Land area, where customary law, including a communal land tenure system, is predominant.

Maize continues to be the most important cash crop as well as food crop for the majority of small farmers in Zambia. In Central Province as well as in Southern and Eastern Provinces, maize and other major crops are cultivated using ox-drawn ploughs. In maize farming, access to suitable land, ox-drawn implements, cattle and inputs such as fertilizer are important. While maize is an important crop in Village C, vegetable production is another of their main farming activities. The area around the village is abundant in dambos, which are utilized by farmers for crop production. Many of the village's farmers practice both upland maize cultivation and dambo gardening. In the

[10] The FNDP has set out nine agricultural sector programs including the Irrigation Development and Support Program, which involves six strategies including: facilitating the establishment of water rights that are supportive of sustainable agricultural development; and promoting the sustainable utilization of wetlands and dambos (Zambia 2006:50).

[11] A team of several researchers including the author has conducted research on the village since the early 1990s. See Shimada 1995.

early 1990s when we first conducted field research in the village, around half of the farmers in the village utilized dambos for vegetable production[12]. However, the size of the dambo gardens was limited; the average size of dambo gardens per household was only 0.5 ha (Shimada 1995: 33; Shimada 2007: 65). This was about one tenth the size of the upland fields. Most of the crops including maize were cultivated in the upland fields during the rainy season, while vegetables such as tomatoes, watermelons, and rapeseed were cultivated in both the upland fields and the dambo gardens[13]. The fact that vegetable production is a mainstay economic activity in Village C implies the importance of water resources, as vegetables are water-intensive crops. By the early 1990s in Village C, dambo land was not common-access but was allocated by the village headman in the same way as upland fields. Dambo land is allocated as an extension of upland allotments, with the rule that the "owner" of an upland allotment can extend his/her farmland borders toward the center of the stream or dambo (Shimada 1995: 31).

The combination of rain-fed upland cultivation and irrigated dambo gardening provides farmers with security against drought damages. The two farming activities are complementary in two respects. First, dambo gardening is a dry-season activity that does not compete for labor and land with upland farming and other activities. Second, the two activities are interconnected in such a way that the revenues from vegetable sales are used for purchasing maize production inputs for the rainy season.

However, rain-fed maize farming and vegetable growing each face a different set of climate uncertainties (related to environmental shocks) and market uncertainties (related to market and policy shocks). While rain-fed maize farming is susceptible to rainfall fluctuations, farmers could expect a certain amount of income from maize production based on fixed input and output prices during the period of state-controlled maize markets prior to the mid-1990s. Even after the liberalization of maize marketing system, the maize price fluctuations are more predictable than those of vegetables. In contrast, while vegetable production on dambo land is more drought-resistant than upland cultivation, farmers are faced with volatile prices at vegetable markets as they fall under the private markets system. This makes revenues realized from vegetable growing less predictable. Since vegetables are perishable, and given the lack of cold storage facilities, vegetable growers face the risk of being forced to sell their produce at giveaway prices or otherwise see their crops rotting away in their gardens.

The irrigation method most farmers practiced in the 1990s was bucket irrigation, which requires manual labor. Dambos possess seepage zones from which the capillary rise of moisture is exploited to grow crops without requiring much water control (Daka 2006: 11). In some areas on the fringes of a dambo, supplementary irrigation water is supplied to crops. Since the groundwater table is shallow in dambo lands, it is easy to dig shallow wells from which farmers can draw water

[12] Hanzawa's survey of 76 households in 1993 shows the magnitude of vegetable production in the village. In the 1992/93 season, 52 of the households interviewed had sold their tomato harvests from upland fields, and 41 households had done so from dambo crops (Hanzawa 1995).

[13] The acreage under cultivation for tomatoes and rapeseed accounted for 94% of the total dambo gardens in one of the village's dambos in 1992 (Shimada 1995: 33). Shimada measured the land size in 1992 and 1993, and found that 16 households managed crops in one dambo.

using buckets.

While protracted economic declines and structural adjustment measures in the 1980s and 1990s adversely affected income and employment for urban dwellers, farming in rural areas with access to markets was less severely affected, thus opening up prospects for better livelihoods in rural areas compared with urban areas. Zambia experienced several rounds of drought in the 1980s and 1990s, which impacted negatively on maize production in many parts of the country (Thurlow & Wobst 2004: 31-32; Kajoba 2007: 87). This made dambo irrigation farming particularly attractive. Under such circumstances, the population of Village C increased rapidly during the 1980s and the first half of the 1990s as people migrated into the village[14]. As a result of the population growth and increased commercialization of agricultural production, growing land use pressures and consequent land scarcity were beginning to be felt by the mid-1990s. Available land became so scarce that there were some cases of disputes over land between villagers as well as with neighboring villages (Kajoba 1995; Kodamaya 1995).

3.2. Effects of Liberalization of Agricultural Markets in the Mid-1990s

The deregulation of agricultural marketing system in the mid-1990s adversely affected small-scale farmers. The liberalization of maize marketing system resulted in price fluctuations and the deterioration of terms of trade for farmers. While input and output prices had been fixed annually during the state-controlled period, after the deregulation the prices fluctuated seasonally and annually. Since maize in Zambia is produced under rain-fed conditions, maize prices fluctuate seasonally according to domestic supplies[15]. After the liberalization that removed fertilizer subsidies, fertilizer prices increased more than maize prices did, so the terms of trade for farmers deteriorated[16]. In addition, fertilizer was not easily available in many rural areas in the years following the liberalization of markets. Maize price fluctuations and deteriorated terms of trade adversely affected maize production for the majority of small-scale farmers. Meanwhile, the devastation of livestock by cattle disease outbreaks exacerbated the situation, as the loss of cattle adversely affected ox-plough cultivation practices (Kajoba 2007). This led many farming households to pursue additional income-generating activities such as charcoal burning, petty trade in agricultural produce, fish trade, and running small shops[17]. Vegetable production in dambo

[14] A relative rise in agricultural employment occurred due to the high proportion of young people in the rural population, as well as the slowdown in rural-to-urban migration as economic conditions deteriorated in the 1980s and 1990s (FFSSA n.d.: 30). See Haller & Merten 2008 for the similar factors at work behind the in-migration of seasonal commercial fishermen to the fisheries in Kafue Flats, which attracted people who sought alternative income-generating activities.

[15] Seasonal maize prices normally reach their peak during the months of February, March and April (just before the harvest). The prices decline between April and June (just after the harvest), and thereafter prices rise again gradually.

[16] In fact, the government continued to be involved in fertilizer distribution through several programs including the Fertilizer Credit Program which was implemented by Food Reserve Agency from 1998. The government reintroduced fertilizer subsidies in 2002 through the Fertilizer Support Program.

[17] Similar responses were common both within and outside Zambia. UNEP 2006 reports that as a response to the poor performance of the formal sector, the diversification and intensification of

gardens also expanded in Village C as farmers sought an additional source of income.

Forest clearing was another important local event related to the environment that was occurring in the mid-1990s. On its eastern side, Village C borders a National Forest Reserve that was effectively protected by the government until the mid-1990s when people from some adjacent local communities, including some from Village C, migrated and settled in the Reserve. About 15 out of 120 households of Village C moved into the forest between 1995 and 1997. By the early 2000s, most of the land in the forest had been cleared for farming. Most of the people who shifted from the village to the forest cleared large tracts of land where they cultivated a large hectarage of maize and grazed a large herd of cattle. Factors behind the migratory event included social tensions between villagers that culminated in the departure of some villagers, many of whom were also motivated by the desire to have a larger land area to cultivate and graze. The event is an illustrative case of "extensification" of farming instead of the preferable "sustainable intensification." The population of the village, which had grown rapidly until the mid-1990s, ceased to increase and became stagnant.

3.3. Development of New Irrigation: Introduction of Treadle Pumps in 2001

Irrigation farming in Village C entered a new stage with the start of a new millennium. In 2001, an NGO called Total Land Care (TLC) came to the village and introduced a new irrigation method utilizing treadle pumps (Shimada 2007). TLC promoted the Vifor (Village Irrigation and Forestry) program and encouraged farmers in the village to form a group to collectively practice new irrigation methods. The organization extended micro-credit for the farmer group to buy treadle pumps, and trained them in irrigation agronomy and treadle pump operation and maintenance. The farmers participating in the Vifor group were required to establish a small land plot for gravity irrigation with furrows and ridges. The land plots were irrigated with water abstracted by treadle pump from a shallow well. FAO's AQUASTAT 2003 estimated that more than 5,000 treadle pumps were in use in Zambia to irrigate a total area of more than 1,200 ha (Daka 2006: 6). A treadle pump has the limited capacity of abstracting water from a depth of up to 8 meters. For this reason, its application is common in dambos where water tables are shallow.

An important note on irrigation and the environment must be added in relation to TLC's development intervention. As the name Vifor (Village Irrigation and Forestry) suggests, TLC was attempting to promote not only irrigation but also social forestry, as it had been doing in Malawi where the organization is based (Bayani 2008)[18]. However, as far as the project in Village C and TLC's activities elsewhere in Zambia in the early 2000s were concerned, the focus was on irrigation rather than on forestry[19]. Except a few farmers practicing agroforestry and conservation

---

informal sector activities occurred, many of which were based on natural resources and may have detrimental impacts on the environment (UNEP 2006: 16).

[18] In Malawi, TLC is also promoting the use of manure and agroforestry. TLC follows the policy that those benefiting from TLC's irrigation program must plant at least 100 trees along a stream bank (Bayani 2008).

[19] References to TLC are made on several pages of Daka 2006, but without any associated mentions of forestry or agro-forestry activities.

farming, other members perceived the project as specifically promoting treadle pump irrigation. The period when treadle pumps were being introduced by TLC also saw actors outside the village promoting other new agricultural practices. One of these was conservation farming promoted by the Conservation Farming Unit of the Zambia National Farmers Union (ZNFU), whereby some farmers in the village introduced these practices, mainly in their upland fields.

The irrigation project of 2001 entailed several new elements. First, it involved a technological development in terms of the shift from bucket irrigation to pump irrigation. A treadle pump can abstract a larger amount of water in a shorter time and can irrigate a larger hectarage of land. It is also so simple to use that it can even be operated by children.

Second, the irrigation project included the establishment of specific small-sized land plots (15m by 30m) for gravity irrigation, which entailed a more intensive use of the land (Shimada 2007)[20]. However, it is not clear whether the intensive use of small plots for irrigation also implied more efficient use of water compared with traditional dambo cultivation. There were also implications for farmers' requirement of cattle and ox-drawn implements because the cultivation of small irrigation plots does not depend on ox-ploughing.

Third, the crops recommended by TLC included not only vegetables but also maize, the staple crop. Before the Vifor project, few farmers grew irrigated maize during the dry season. Since the introduction of the project, some farmers have practiced "winter maize" cultivation with irrigation. This was in line with the new situation under the liberalized agricultural market and the government policy encouraging farmers to grow winter maize. Winter maize is planted around May and harvested around October and November when maize can fetch higher prices.

It is difficult to quantitatively estimate the impact of treadle pumps on water demand because it depends on several factors; in addition to the abstraction capacity of a treadle pump, the calculation must include evaporation rates, the type of crops irrigated (their water intensity and evaporation rates), irrigation methods (considering their water use efficiency or irrigation efficiency), and acreage under irrigation. Although the introduction of treadle pumps can increase water demand, the associated introduction of a new irrigation agronomy and diversification of crops irrigated can also affect the water demand. In addition, such an increase in the total water demand could have been small, because the number of farmers who adopted the use of a treadle pump[21] was small and the size of the land irrigated by each farmer was also small.

Since TLC and Vifor were instrumental in introducing the new irrigation project, farmers' access to new technology and financial resources depended on their membership in the Vifor group. Again, to be entitled to subsidized fertilizer under the government's Fertilizer Support Program, farmers were required to organize themselves into a co-operative[22], thus effectively encouraging

[20] This can be compared with the average size of a dambo garden in 1992, which was 0.4 ha per household (Shimada 1995: 33; Shimada 2007).

[21] This was due to the cost of the pump. In 2001, a treadle pump cost 480,000 kwacha (US$133) (Shimada 2007). In 2008, a treadle pump set (including the treadle pump, outlet pipes, inlet pipes and a foot valve) cost 570,000 kwacha (US$162).

[22] The Cooperative Societies Act no.20 of 1998 provides the legal framework for co-operatives in Zambia.

farmers to do so. In Village C, 21 farmers formed the J.C. Irrigation and Savings Club in 2001 to have access to government-subsidized fertilizer (Shimada 2007)[23].

3.4. Introduction of Engine Pumps

Another development in irrigation methods in Village C occurred around 2005. A growing number of farmers began to purchase engine pumps. By 2008, about a dozen farmers in the village were practicing irrigation farming using engine pumps. In fact, many of the engine pump owners were those who had bought treadle pumps in 2001[24]. In other words, there was a shift from treadle pumps to engine pumps among those farmers who practiced pump irrigation. One farmer bought an engine pump for 1.25 million kwacha (or US$350) in 2007[25].

Another development in irrigation was the introduction of drip irrigation. Two organizations called IDE and Cropserve held a training course on drip irrigation in March 2008, and subsequently some farmers in the village were introducing drip irrigation[26]. In 2008, a drip irrigation kit cost 230,000 kwacha (or US$66). A drum is installed at an elevation of 2 to 3 m above ground to provide a low-pressure head that is sufficient to operate micro-tube drippers. Water is pumped from the source to the reservoir, and the micro-tubes emit water drop by drop onto the root zone surrounding the crops.

In 2007, another group of farmers practicing irrigation organized themselves into a co-operative called M. Vegetable Growers[27]. M. Vegetable Growers had 35 members and spanned 4 villages including Village C. The co-operative was assisted by the Rural Prosperity Initiative (RPI) of IDE. M. Vegetable Growers and two other co-operatives were organized into the IDE-RPI Zone 2 in June 2008.

Some changes in the economic and policy environments helped with the diffusion of engine pumps in the village, including economic liberalization policies, the reduction of duties on irrigation equipment, and the recovery of the Zambian economy. With the trade liberalization in the first half of the 1990s, imported goods became more easily available. The Zambian economy, after 25 years of stagnation and contraction, recorded 8 consecutive years of growth since 1999. The economic recovery was accelerated by the rapid expansion of copper exports, which jumped from US$365 million in 1998 to US$3.084 billion in 2006 (IMF 2006; IMF 2008). The expansion of exports has resulted in an appreciation of the Zambian currency, from 4779 kwacha per US dollar in 2004 to 3603 in 2006. The reduction of duty, VAT, and customs as recommended in the National Irrigation Plan in 2005 has also helped to reduce the cost of irrigation equipment. These changes

---

[23] J.C. are the initials of a former village headman's name. Before this Club, two co-operatives were formed in the area in 1998 and 1999 to gain access to Fertilizer Credit Program.

[24] This shift does not seem to be unique to Village C farmers; farmers in the other groups trained by TLC were reported to be investing in motorized-pump irrigation systems following their use of treadle pump irrigation (Daka 2006 : 22).

[25] Engine pumps were not entirely new to the village. A few farmers had bought engine pumps in 1992 and 1993 but they resold them after a few years.

[26] IDE is a US-based NGO and Cropserve is a private company. IDE trains farmers and links farmers with service providers.

[27] M. stands for the area's name.

resulted in imported engine pumps coming within the financial reach of more small-scale farmers[28].

However, it is also a fact that only a fraction of the farmers in the village can afford engine pumps. An engine pump costs two and half times more than a treadle pump. In addition to their initial cost, engine pumps require much greater maintenance costs, including fuel, than do treadle pumps. Consequently, the number of households who can afford an engine pump is likely to be small.

One factor that encouraged farmers to adopt engine pumps was an increased demand for water. As some households wanted to expand their irrigation farming, they were faced with the limited abstraction capacity of a treadle pump. A treadle pump also depends on the availability of labor, which can be a constraint on expanded irrigation farming. A treadle pump can be operated by children, who in fact were an important source of labor, but they were not available during the school terms.

One of the impacts of the introduction of engine pumps was the extension of irrigation to upland fields. Whereas a treadle pump is restricted to the irrigation of dambo lands due to its limited capacity, an engine pump can be used to irrigate even upland plots. According to our informants in the village, the irrigation of upland plots began two years ago and has been expanding since then.

A related impact of engine pumps is the effect on water consumption and its distribution among water users. An engine pump is more powerful than a treadle pump and this can result in increased water consumption. However, as already noted, it is difficult to estimate changes in water consumption because it depends on many factors. While the introduction of engine pumps and the concomitant extension of the irrigated area into upland fields can cause increased water consumption, the adoption of drip irrigation, originally developed as a water-saving practice, works as a counterbalance by contributing to water savings (Smil 2000). Since the number of farmers practicing irrigation with engine pumps is small, and since they are likely to consume a much larger amount of water than those without engine pumps, then the amount of water consumed will be disproportionately concentrated among a small number of farmers[29].

While the introduction of engine pumps is likely to result in increased water demand among those farmers, the total water demand of the village may not see a marked increase due to the stagnant growth of the village population since the mid-1990s (in contrast to its rapid population growth in the first half of the 1990s). The stagnant population trends were caused by a combination of several local and national factors[30].

---

[28] Another noticeable change associated with export expansions and kwacha appreciation is the rapid increase in automobile imports.

[29] Since the water for the villagers' domestic use is also drawn from wells, this may lead to competition for water between irrigation and domestic use.

[30] Local factors include (as described above): the out-migration of some households to the neighboring forest reserve in the mid-1990s; and the moving out of some people from the village due to social tensions. National factors include: the recovery of the Zambian economy since 2000, which brought some improvements in employment and income in urban areas.

The issue of the amount of water use and its distribution among users is related to the control and collective management of water resources. Access to land including dambos, which falls under the communal land tenure system, is controlled by chiefs and village headmen. However, a villager can dig a well on his/her allocated land without seeking the permission or consent of a chief, headman, or other villagers. While there are some farming groups and co-operatives in the area, they mainly have the purpose of gaining access to subsidized fertilizer and other state and NGO support; there are no groups operating as a water-users association. Thus there is no mechanism of collective control or management of groundwater abstracted from wells, and consequently water resources can be over-used in de facto open-access situations. As far as surface water such as streams is concerned, there are some customary controls. According to our informants in the village, there is an acknowledgment that "streams are communal and there are no boundaries for streams [it means that unlike lands streams are not allocated to individuals]," and as such there is some control of the use of stream water. When a farmer wants to build an earthen dam on a stream, he/she is required to gain the consent of farmers who live along that stream.

4. Discussion and Conclusion

In this paper, we traced the development of small-scale irrigation based on the experiences of one village in central Zambia. Irrigation farming in the village began as traditional or informal irrigation, whereby vegetables were grown in dambo gardens with the use of bucket irrigation. By the early 1990s, vegetable production in dambo gardens had become an important source of income for many farmers in the village. The combination of rain-fed maize cultivation in upland fields and vegetable growing in dambo gardens provided farmers with relatively secure and diversified income sources. As economic declines and structural adjustment measures in the 1980s and 1990s adversely affected the livelihoods of urban dwellers, farming in this village, with its water resources, came to be economically more attractive. Irrigated vegetable production in dambo gardens became more popular as an additional or alternative income generating activity after the mid-1990s when the agricultural market was liberalized. In the early 2000s, some farmers in the village shifted from bucket irrigation to treadle pump irrigation with the assistance of a non-governmental organization. The introduction of treadle pumps entailed new methods in irrigation agronomy such as the use of furrows and pipes, the cultivation of winter maize, and more intensive use of the land. The second half of the 2000s is seeing another development in the use of irrigation technology, with some farmers introducing engine pumps and drip irrigation. As irrigation methods developed from bucket irrigation to treadle pump and engine pump irrigation, the water consumption level of each farmer likely increased.

The development of irrigation farming in Village C illustrates a type of coping strategy used by farmers to respond and adapt to new opportunities and constraints. Opportunities and farmer responses in the village must be seen against the backdrop of economic, geographical and environmental conditions. The typical farming system found in the study area, which comprises the two practices of rain-fed maize cultivation and irrigated dambo gardening, is an expression of farming adaptations in the face of uncertainties both in rainfall and market conditions. The

introduction of new irrigation practices by some farmers can be considered an expansion of the dambo gardening component of the system. Those farmers using new irrigation methods retain the two farming practices so as to be adaptive to different sets of opportunities and risks.

The development interventions of NGOs played an important role in the adoption and diffusion of treadle pumps and drip irrigation. Support from NGOs related to irrigation development placed greater emphasis on poverty reduction, income generation, and market sales than on environmental and ecological aspects. One of the two NGOs involved in promoting small-scale irrigation in the village emphasized linking farmers with the market, while the other was perceived by farmers to stress irrigation despite its usual inclusive focus on both irrigation and forestry. Although irrigation farming in the research site has developed without stimulation by any specific government support programs, the government contributed to the policy setting, facilitating the exploitation of water resources for irrigation without paying due attention to environmental considerations including regulations on the use of wetlands and water resources.

Economic and geographical conditions also played a part in the farmers' opportunities and responses. This can be illustrated by comparing the study area with other areas. When compared with Gwembe Valley in Southern Province, it is evident that the area where our case study village is situated has much more favorable conditions. Farmers in the study site have easy access to markets for selling their produce, whereas Gwembe people cannot count on the availability of markets. The former can invest in irrigation equipment while expecting a good return, whereas for the latter people, agricultural investment is a gamble in which the odds are too high due to climatic uncertainties and unpredictable government and donor policies (Cliggett et al. 2007).

It is quite clear that the farmers in the village studied are not "Powerless Spectators," but either "Coping Actors" or "Adaptive Co-managers" as described in Fabricius' categories of communities. The villagers continuously invested in new agricultural management practices and land-care techniques. Knowledge networks enabled the villagers to co-opt new technology from outsiders (Fabricius et al. 2007). However, the investments and technology promoted are mainly associated with income-generating activities, which may allow the damaging of ecosystems and thus undermine their capacity to generate services. Although some farmers introduced conservation farming methods which were promoted by a non-government organization, the village lacks systematic efforts to invest in the long-term management of ecosystem services or to take appropriate action for long-term sustainability. It seems that the dambos of the village are opportunistically used without any plan for maintaining their capacity to generate services.

The case of the village studied demonstrates that the farmers' responses were not necessarily unified, coordinated responses of the "community" (in this case, the village). The responses to the new farming practices and NGO support mainly occurred at the level of individual farmers and farmer groups. Treadle pumps, drip irrigation, and conservation farming were respectively introduced by different farmer groups, with some of their members overlapping and including farmers from neighboring villages, while engine pumps were introduced by individual farmers. In addition to these farmer groups, several other groups were formed to gain access to government-subsidized fertilizer. Their strategy is to continue the type of farming predominant in

the 1980s, that is, rain-fed maize farming dependent on government-subsidized fertilizer, and this is quite different from the strategy of pursuing the introduction of new irrigation technology. However, it is important not to polarize this distinction, because many farmers combine upland maize cultivation and dambo gardening, and the two strategies coexist at the individual farmer level, with some differences in emphasis. The out-migration of some villagers to the neighboring forest reserve in the mid-1990s demonstrates how individuals and subgroups in the community had different preferences for resource use with various responses to opportunities and constraints.

Farmers' responses to new opportunities are not only conditioned by the configuration of those opportunities but also constrained by the farmers' assets or capital. As irrigation methods shifted to those entailing more capital-intensive technology such as engine pumps, farmers' responses to new opportunities depended increasingly on their resource or capital base including social capital[31]. Whereas any farmer with access to dambo land and labor can undertake traditional irrigation practices, only those farmers with sufficient financial resources can afford the initial investment and maintenance outlays of new irrigation methods. Since membership in farmer groups is required in order to be entitled to support from NGOs and the state, social capital might play a role in the access to new irrigation technology and subsidized inputs. One probable consequence of this situation is a widening gap between those who have sufficient resources to respond to new opportunities and those without. In other words, irrigation development has benefited a small proportion of farmers, while the majority of the village population has been excluded from the benefits of the new technology. However, even those farmers who are wealthy enough to invest in expanded crop production and new irrigation technology are facing a risk because they are more dependent on private markets, making them vulnerable to market price fluctuations[32].

Although it is difficult to quantitatively estimate the impact of pump irrigation on water demand because of many factors affecting water use, the shift from bucket irrigation to treadle pump and engine pump irrigation in the area has likely had a substantial impact on the use of water resources, especially groundwater. Since there are no customary or formal regulations or control of the use of groundwater, current opportunistic use of groundwater for irrigation agriculture can result in the overuse of groundwater and might cause its decrease and depletion. Zambia, in terms of a national total, is well-endowed with water resources, both surface water and groundwater, and there are many prospects for exploiting this abundant irrigation potential. However, the water resource endowment varies from area to area and water resources in particular local areas can be much scarcer than the national total figures suggest[33]. As irrigation farming provides small-scale

---

[31] However, intensive irrigation farming on small plots depends less on cattle and ox-drawn implements, which are important capital for upland cultivation and traditional dambo gardening.

[32] See Liverman's studies for information on the vulnerability of the production of fruit and vegetable crops for export markets to both price fluctuations and climate change (cited in O'Brien & Leichenko 2000).

[33] PRSP 2002-2004 points out that there are significant variations [in the available water resources] across the country, and there is a strong seasonal distribution leading to water deficits in certain localities. Competition for available water resources is expected to increase (Zambia 2002:

farmers with an important source of income as well as security against damages from rainfall fluctuations, it is crucial to introduce some mechanism of control and management of water resources which enables the sustainable use of this important resource. Last, we must add that if one looks at the distribution of water consumption at the national level, it has remained highly skewed with a large proportion of water resources being consumed by commercial farms for irrigation and for industrial use such as by mining companies, while water use by small farmers for irrigation is just emerging. Under these circumstances, control or regulation of water resources should not be imposed on small-scale farmers in a top-down manner. Instead, it should be managed in a participatory way based on the idea that natural resources are most effectively managed when responsibility is shared with democratic local institutions[34].

References:

Agrawal, A. and Gibson, C. 1999 "Enchantment and Disenchantment: the Role of Community in Natural Resource Conservation", *World Development*, vol. 27, no.4: 629-649.

Bayani, E.K. 2008 "Malawi's Initiatives in Responses to Climate Change" *LEISA Magazine* 24 (4) December 2008: 34-5.

Benson, Todd 2004 "Africa's Food and Nutrition Security Situation", 2020 Discussion Paper 37, International Food Policy Research Institute.

Blaikie, P. 2006 "Is Small Really Beautiful? Community-based Natural Resource Management in Malawi and Botswana," *World Development* vol.34, no.11, pp.1942-1957.

Bohensky, E. and Lynam, T. 2005 "Evaluating Responses in Complex Adaptive Systems: Insights on Water Management from the Southern African Millennium Ecosystem Assessment (SAfMA)", *Ecology and Society*, vol. 10, no.1

Chileshe, P., Trottier, J. & Wilson, L. 2005 "Translation of Water Rights and Water Management in Zambia", Paper presented at International Workshop on 'African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa', January 2005, Johannesburg.

Cliggett, L., Colson, E., Hay, R., Scudder, T. & Unruh, J. 2007 "Chronic Uncertainty and Momentary Opportunity: A half century of adaptation among Zambia's Gwembe Tonga", *Human Ecology*, 35

Daka, A.E. 2006 "Experiences with Micro Agricultural Water Management Technologies: Zambia" (Report submitted to the International Water Management Institute, Southern Africa Sub-regional Office)
http://sarpn.org.za/documents/d0002066/Zambia_AWM_Report.pdf (accessed December 2008)

---

91).

[34] One issue relating to water resource management under the Community-based Natural Resource Management regime is that the boundaries of natural resources such as watersheds may bear no resemblance to community boundaries. One approach is to encourage the formation of appropriate federations and networks (Blaikie 2006: 1944; Ribot 2002: 14-5).

Earth Trends 2003 “Water Resources and Freshwater Ecosystems – Zambia”

Fabricius, C., Folke, C., Cundill, G. and Schultz, L. 2007 “Powerless Spectators, Coping Actors, and Adaptive Co-managers: a Synthesis of the Role of Communities in Ecosystem Management”, *Ecology and Society*, vol. 12, no.1

FFSSA 2004 “Achieving Food Security in Southern Africa: Policy Issues and Options”, FFSSA Synthesis Paper, Forum for Food Security in Southern Africa. http://www/odi/org/uk/food-security-forum

FFSSA n.d. “Zambia Food Security Issues Paper”, Forum for Food Security in Southern Africa

Haller, T. & Merten, S. 2008 “’We are Zambians – Don’t Tell Us How to Fish!’ Institutional Change, Power Relations and Conflicts in the Kafue Flats Fisheries in Zambia” *Human Ecology*, no.36: 699-715

Hanzawa, K. 1995 “Agricultural Production and Economic Activity in Chinena Village: Economical Significance of Dambo Use”, in Shimada ed. 1995.

IMF 2006 “Zambia: Selected Issues and Statistical Appendix” (IMF Country Report no.06/118),

IMF 2008 “Zambia: Statistical Appendix” (IMF Country Report no.08/30), January 2008.

Kajoba, G.M. 1995 “Changing Perceptions on Agricultural Land Tenure under Commercialization among Small-scale Farmers: the Case of Chinena Village in Chibombo District (Kabwe Rural), Central Zambia” in Shimada ed. 1995.

Kajoba, G.M. 2007 “Vulnerability and Resilience of Rural Society in Zambia: From the Viewpoint of Land Tenure and Food Security” in Vulnerability and Resilience of Social-Ecological Systems: Annual Project Report, RIHN.

Kodamaya, S. 1995 “Migration, Population Growth and Ethnic Diversity of a Village in Central Zambia”, *Hitotsubashi Journal of Social Studies*, vol.27, no.2.

O’Brien K.L & Leichenko, R. M. 2000 “Double Exposure: assessing the impacts of climate change within the context of economic globalization”, *Global Environmental Change*, no. 10: 221-232.

Ribot, J.C. 2002 *Democratic Decentralization of Natural Resources: Institutionalizing Popular Participation*, World Resources Institute.

Sanginga, P.C., Kamugisha, R.N. and Martin, A.M. 2007 “The Dynamics of Social Capital and Conflict Management in Multiple Resource Regimes: A Case of the Southwestern Highlands of Uganda”, *Ecology and Society*, vol. 12, no. 1

Shimada, S. ed. 1995 *Agricultural Production and Environmental Change of Dambo*. Tohoku University/ University of Zambia

Shimada, S. 2007 *Gendai Africa Nouson (Rural Transition in Modern Africa: Challenge of Area Study to Read Change)*, Kokon-Shoin, Tokyo. (in Japanese)

Sievers, P. 2006 “Zambia Water Sector: Challenges for Integrated Water Resources Management in Zambia”, paper presented at Danida Water Sector Seminar, January 2006, Accra Ghana

Smil, V. 2000 *Feeding the World: a Challenge for the Twenty-first Century*. Massachusetts Institute of Technology.

Thurlow, J. and Wobst, P. 2004 “The Road to Pro-Poor Growth in Zambia: Past Lessons and Future

Challenges", Operationalising Pro-Poor Growth: A Country Case Study on Zambia, A joint initiative of AFD, BMZ, DFID, and the World Bank

UNEP (United Nations Environment Programme) 2006 *Africa Environment Outlook 2: Our Environment, Our Wealth*. UNEP, Nairobi.

Zamani, Gh. H., Gorgievski-Duijvesteijn, M.J. & Zarafshani, M. 2006 "Coping with Drought: Towards a Multilevel Understanding Based on Conservation of Resources Theory", *Human Ecology* 34.

Zambia 2002 Ministry of Finance and National Planning, *Zambia Poverty Reduction Strategy Paper 2002-2004*. Lusaka.

Zambia 2004 Ministry of Agriculture and Co-operatives, *National Agricultural Policy 2004-2015*. Lusaka

Zambia 2005 Ministry of Agriculture and Co-operatives, *National Irrigation Plan (NIP)*. Lusaka.

Zambia 2006 *Fifth National Development Plan 2006-2010*. Lusaka