COMMUNITY MOBILIZATION FOR THE CONTROL OF RAVINE EROSION WITH VETIVER TECHNOLOGY IN THE CONGO

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ABSTRACT

In the Democratic Republic of Congo (DRC), the majority of the urban centers experience massive surges by the rural populations. This rural exodus, associated with the high birth rate, is among the principal factors that increase the population in these urban environments. The demographic pressure is known to have several harmful consequences on the quality of the habitat. This situation leads people to occupy any new sites, even rough grounds, without taking account of standards of urbanization. Consequently, with the high rainfall intensity, the runoff waters on these poor zones are not controlled. It follows then the appearance of numerous gully and ravine heads and their progression with time to the centers of certain districts, causing enormous infrastructure damages (destruction of the public buildings, dwelling houses, roads etc) and sometimes human lives.

The town of Kikwit in the province of Bandundu in the West of the DRC, is among the cities most threatened by water erosions. During these last decades, this damage became increasingly important. Unfortunately, the public authority gives only little and even no attention to the erosion problems, with great concerns to the local population. To fight against the advancement of these ravine heads and to protect their dwellings, the populations of Kikwit use certain techniques such as barriers with sand bags, dumps of rubbish or household refuse, planting of bamboos etc. Unfortunately for them, all these methods of erosion control generally only provide temporary and transitory solutions.

Face to this situation, the vetiver technology, which consists of planting successive hedges of vetiver grass (*Vetiveria zizanioides*) perpendicular to the direction of flows of runoff waters, proved to be an alternative, capabable of providing an effective and durable solution to the problems of ravine heads advancement.

This is why, with the financial support of the USAID, the American NGO, Innovative Resources Management (IRM) brought to the people of Kikwit the new technique of stopping the advancement of ravine, using the vetiver grass. With this aim, ravine ITPK was selected as a demonstration site to fight ravine erosion with vetiver technology.

The community mobilization allowed the use of the high intensity manual labor, the slopes of ravine ITPK was reshaped with the creation of the numerous terraces on contour line. On these terraces several successive hedges of vetiver were planted.

Six months after planting on this demonstration site, vetiver developed lively dense hedges with its leaves and rigid stems, thus making it possible to reduce the speed of runoff water, to dissipate its energy and to increase water infiltration. In addition, the roots of vetiver would go down to more than two meters in depth, made it possible to stabilize the slopes of this ravine. Consequently, the three heads of ravine ITPK are stabilized and stopped by vetiver grass, saving the destruction of several houses in the neighborhood Malawi, the school ITPK, the Jesuits convent, the general hospital, the central market of this city

KEY WORDS: Congo, gully stabilisation, community mobilisation

1.0 INTRODUCTION

Water is an important element in the life of all living things. Rains in tropical zones are one of the ways nature provides water to a specific zone. Rain water falling on soils can take one of three possible movements; evaporation, infiltration or run-off (Dupriez and DeLenner, 1986).

This last movement is the principal cause of damage encountered in tropical zones, notably water-induced erosions, because, if flowing water doesn't encounter enough resistance, its speed turns turbulent and soil particles as well as uprooted vegetation with superficial root systems will be pushed from its path and deposit further down stream as its flow speed diminishes.

Thus erosion corresponds to an uprooting, transport and deposit or sedimentation of soil particles (Lumbuenamo, 1999). Erosion is possible, either favorable or is limited in accordance to the following factors:

- **Ground cover condition:** It is the principal factor determining erosion. The ground cover cushions the impact of falling rain droplets, slows down water run off and helps infiltrate rain water into the soil.
- **The terrain's topography:** This is of critical important on the flow speed. The steeper and/or longer the slope, the faster the run-off and consequently the more serious the erosion.
- **The physical properties of the terrain, notably its texture and structure**: They provide the soil with a certain capacity of resisting the break up and desegregations of soil particles.

Generally, in the Democratic Republic of Congo and particularly in certain built-up urban areas, the demographic growth and the anarchic occupation of land absence of urban norms put enormous negative pressure on the above mentioned factors. Over the past 30 years, the lack of efficient technical management of water run-off after rains or the badly damaged drainage system, are at the origin of serious erosions problems. These erosions create major social problem in light of the number of destroyed infrastructures (roads, bridges, public buildings, dwellings, etc.) both past and present, which continue to startle and aggravate the lives of a powerless local population.

The battle against soil erosion requires enormous amounts of financing in the Democratic Republic of Congo because the ravines there are huge. Unfortunately, public authorities only become interested once the damages have reached insurmountable proportions and even then they are no longer able to intervene in all the areas affected. Even in the areas where there has been some intervention by civil engineers, the protective or remedial works constructed did not last because there no effective anti-erosion control measures were used. Consequently, with intensifying rainfalls in the country and following several years of erosion, these anti-erosion works gave way and the ravines become even more threatening and unmanageable than before. Existing ravines continued to become larger and new ravines developed, all of this being before the eyes of powerless population, who witnessed all these efforts but saw little or no results.

To tackle this difficult erosion problem faced by the local population, with the financial support of USAID (United States Agency for the International Development), IRM (Innovative Resources Management) an American NGO initiated two demonstration sites using the Vetiver Technology in two provinces in the DRC (Bandundu and Equateur). This report discusses the anti-erosion demonstration site established the Kikwit, a town in Bandundu province.

2.0 SITE, MATERIALS AND WORK METHODS

2.1 Demonstration Site

2.1.1. Summary description of the Kikwit town

According to Kakesa and Mubanga (2002), the town of Kikwit has the densest populated area in the Bandundu province. It extends over $92km^2$ and is situated 525 km from the capital of Kinshasa in the south-east of the DRC. It is at an altitude between 350 and 485m, and at Latitude 5 02 South and longitude 18 48 East. The landscape of this town is varied. Neighborhoods have been built in the valleys or between stream beds of the Kwilu River. Other neighborhoods are on the slopes and beds of this same river. Slopes of 25 degrees are common in the region.

Kikwit's climate is tropical and humid of the Aw4 type according to the Koppen classification, with 8 months of rainy season (September to April) and 4 months of dry season (May to August). The average yearly temperature is 25^0C with $3\text{-}5^0$C variation. Average annual rainfall is 1,500mm. There is a great variation in the soil of Kikwit. The superficial cover is often of a sandy nature and at the deeper level one finds gray and red clay, as well as argillites. The vegetative coverage varies depending on the topography. There is grassy savannas on the plateau, forested savannas on the slopes and forests in the valleys.

2.1.2. The Kikwit Ravine Evolution

Kikwit's large ravines have existed for a long time according to Mukubu (2002). For years, there were neither efforts nor decisions by the national or regional governments or of the local municipality to prevent soil erosion in the valleys surrounding the town. Soil erosions and mud slides developed rapidly year after year with the abundant rainfall and increased construction for which there was no urban planning. With defective and/or lack of appropriate drainage systems, rushing water flowed through small cracks of ravines, and with gathering speed down he slopes, carried stones, bricks, large amounts of mud and debris, unearthing trees and bushes.

With time, the ravines become much greater in size and progressively entered the town, tearing down hundreds of houses, schools, roads and other used community infrastructures.

The Kikwit ravines generally have a mobile bed, according to the Viers technology (1983), due to the frequent interventions that change their shape and direction. These sites have become so denuded and precarious that the entire population of neighborhoods had no other choice than to leave.

Today, this natural curse preoccupies the populations, and with continual reoccurrence, the meager efforts to stop the evolution erosion are not enough. The town has already been divided isolated patches.

2.1.3. Presentation of the experimental ravine: ITPK Ravine

Previously named Malawi Ravine, the three heads have already reached the neighborhood bearing the same name and have caused the disappearance of houses in the Malawi and Katamosolo neighborhoods. The progression of these three heads of the ITPK ravine is menacing the only professional technical school of the town (ITPK), the general hospital, the central market, the cathedral and the biggest paved road of the town. Its depth has reached around 5-7 m at the level of these structures and 15-20 m at the bottom of the ravine.

2.2 Materials Used

2.2.1 Vetiver Presentation

Vetiveria zizanioides was used as the plant material to stabilize the heads of the IPTK ravine. This plant is a vivacious gaminea (or poaceae), of the panioideae (or adnropogoanideae) sub-family and sorghinae sub-sub-family. Some specialists indicate its origins are not precisely known; others have concluded that *Vetiveria zizanioides* originates from North India (National Research Council, 1993).

In the battle against soil erosion, this plant has specific anti-erosion properties not found in other grasses. According to Rachmeler (2003) and Truong (2000), its rigid long and dense roots, can penetrate a depth of 3-4 m, which provides soils a measurable resistance to erosion forces.

The leaf/stems of the vetiver are rigid and upright. When planted closely together, Vetiver plants form a dense and thick hedge. The hedge resists sand storms and plays the role of a retaining filter of soil particles and all other sediments. The plants in a hedge form dissipate and reduce run-off, thus favoring the waters infiltration into the soil. (National Research Council, 1993, Juliard *et al*, 2001; and Truong, 2004).

Vetiver tolerates wide range of conditions of climate with the exception of light since it develops best in full sunlight and doesn't do well in shade (Goudiaby, 2003). It can resist extreme temperatures of -14C to 60C and can grow well in zones where the average yearly rainfall is between 450 and 5000 mm. Vetiver can also tolerate highly acidic and alkaline soils and survives in soils where the pH varies from 3.0 to 12.5. It also tolerates soils that are polluted by heavy metal and other types of chemical pollutants (Truong, 2000).

Vetiver flowers but sets no seeds, so it is sterile. The plant can only multiply by separating tillers from the clump. Therefore, the plant is non-invasive and will not take over a new environment unless it has been planted there. (National Research Council, 1993, World Bank, 2000 and Truong, 2004).

2.2.2. Work Materials

Ordinary field tools were used for this demonstration site such as: hoes, machetes, spades, shovels, wheelbarrows and ropes.

2.3 Work Methodology

The erosion problem in the town of Kikwit mostly affects the local population who are the first victims. To realize the objectives of this project, notably to show the local population new anti-erosion techniques with the *Vetiver Zizanioides*, it was necessary to first mobilize the local community in order to implicate them directly in this endeavor (Photo 1)

Photo 1: Property threatened and community concerns and participation

2.3.1. Training and Establishing Vetiver nurseries

The participatory method of this demonstration was of great importance. The active participation of the local population was sought for the execution of this project. With the support of IRM's "Innovative Resources Management" technique, the participatory process began with vetiver information-training workshops. As a result, certain local associations became actively involved by establishing their own vetiver nurseries in order to meet the planned quantity requirements for a demonstration plot. This multiplication phase took 12 months, from October 2004 until September 2005. Implicating the local community in multiplying vetiver had a double advantage; not only did it allowed the population to amass vegetative materials for their individual needs, it also offered them a new source of income through the sale of the vetiver shoots (Photo 2).

Photo 2: Community support and participation through demonstration

2.3.2. Implementation of the Vetiver Technology Demonstration Site

The vetiver system consists of planting one or several hedges along the slope's contour lines. If the area to be protected is very steep, one must initially readjust the profile the ravine prior to planting the hedges.

a. Re-profiling the ravine through with slope terracing

The slopes of a ravine are generally steep, very sharp and steeper than 45º. Under these conditions, the slopes are not stable and are often subject to landslides and collapse until reaching an equilibrium profile. It is therefore difficult and nearly impossible to plant a hedge of vetiver along contour lines in this case. Thus we established successive terracing along the slope to facilitate the planting and to create a more stable slope profile to prevent further collapses or landslides (Fig.1 and Photo 3).

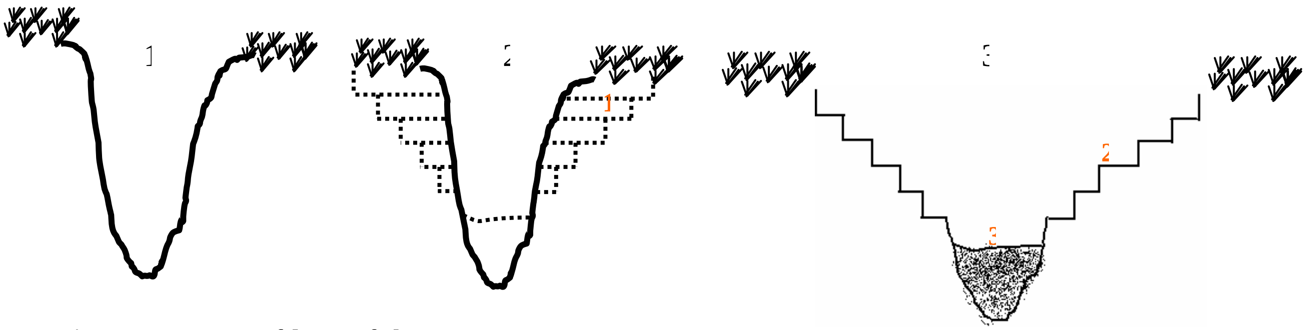

Figure 1. Re-profiling of the ravines
Legend*:* 1: cutting away   2; Terracing   3: fill dirt

Photo 3: Ravine ITPKA before re-profiling   Re-profiling the slopes of ravine ITPKA

These terraces have variable height and width depending on soil texture. Cuts are easy to make on loam and sandy loam soils. Nevertheless, creating terraces on sandy soil is more difficult due to the fragility of the composition. Under these conditions, we place tree branches secured by sinking posts in places to secure particles of the fragile soil. Terraces of this type were generally 50 to 100 cm in width and height (Photo 4).

Photo 4: Retaining barriers built with tree branches

b. Vetiver Planting (Hedge placing)

The successive vetiver hedges were planted on terraces contour lines established during the re-profiling of the ravines. The distance between two hedgerows were set between 50-100cm and the splits (composed of three tillers) were planted 10 cm apart in order to quickly form a dense hedge (usually after a few months) (Photo 5).

Photo 5: Planting vetiver hedges on contour lines on the terraces

c. Maintenance
After planting, regular maintenance visits were made during the first 4 months. These maintenance visits consisted primarily of watering right after replanting to assure good establishment. Three weeks after the initial planting, a few plants had not survived, and these were replaced with new ones in order to avoid gaps between plants and to assure hedge density. According to need, areas were hoed and fertilizer was applied (NPK: 17-17-17 and Urea) to reduce weeds and to permit good vetiver plant growth.

3.0 PRESENTATION AND DISCUSSION OF RESULTS

The goal of these demonstration sites was to show the local population the practical and educational impact of vetiver against erosion. Because of its non scientific characteristics, no quantitative parameters were taken. The results are more visual and qualitative, and appreciated more by simple observation than measured or quantified data. It was an example of visually seeing whether plants survived, grew and developed, and whether the hedges held, whether vetiver hedges stopped ravine erosion or not and whether there were further landslide.

The table and the photos below show the results and the performance of the ravine after one, 60, 120 and 240 days after using the vetiver system on the ITPK demonstration site. The area of the site covered was 15 000m.

	After 1 day	**60 days**	**120 days**	**240 days**
Plant development	-	+/-	+	+ +
Dense hedge formation	-	+/-	+	+ +
Progression ravine head	-	-	-	-
Slippage of ravin sloopes	-	-	-	-

Legend: - negative/none
+/- : average
+ : good
++ : very good

The above table shows that re-profiling the ravine to plant vetiver permitted changing the slopes into terraces that could follow the contour lines. Vetiver was planted in successive hedgerows as illustrated in Photo 6.

At this stage, the vetiver plants could not yet develop because they needed a few days to adapt to their new environment. Therefore, one could not observe the forming of the dense hedgerows as they relate or depend on the level of development of the plants. On the other hand, the extension of the ravine heads and landslides had been stopped by the time the picture was taken, not because of the Vetiver, but mostly because of the re-profiling which gave the slopes a profile of equilibrium. The water retention basins also stopped the progress of the heads as they limited the water run-off on the ravine before the vetiver hedges had reached an optimum development height capable of stabilizing the site.

Photo 6: Panoramic view of the ITPK Ravine, showing Vetiver hedges along contour lines

However, 60 days after planning (photos 6 and 7), these plants had reached their average growth level, leaves started to reach normal heights and the new tillers had grown from the base. Consequently, hedges density was also average, that is, one could still see space and distinguish between the plants in the hedgerow (Photo 7).

Photo 7: Vetiver growth at 60 days

After 120 days, one could see that the vetiver plants started to reach a good level of growth by observing the height of its leaves and the growth of new and more tillers. Growth was reaching a point were plants in the hedgerows began close in on each other permitted the hedge to become more dense as compared to 60 days. No further landslides were observed. The photos show the site at 120 days (Photo 8).

Photo 8: Vetiver growth at 120 days

At 240 days after the start of the demonstration plot, plants had reached their maximum height at approximately 1.5 to 2m providing healthy and dense hedgerows resulting from new tillers bunched close to each other. This eliminated spacing between plants in the hedgerows. Vetiver hedge development on the site transformed the landscape into a form of savanna, allowing the growth of other new and indigenous grasses. The three heads of the ITPK ravine and its slopes have totally stabilized by the dense savanna of vetiver as shows on the above photos.

Photo 9: Vetiver growth at 240 days

4.0 CONCLUSION

Erosion in and around the town of Kikwit has existed for many years. The encroachment and damage it caused become an unmanageable problem for the local population and one without a solution for the public authorities. For many years, efforts exerted by the populations to fight against erosion were ineffective. Vetiver technology has proven effective as a means for erosion control and in mobilizing community contribution to solving the problem. It proved to be an appropriate option to experiment and demonstrate in the heavily populated town of Kikwit. It received the support of IRM with financing from USAID.

Among the hundreds of erosion sites in the town of Kikwit, the ITPK site was selected for its serious erosion problem to serve as the demonstration site for testing vetiver technology. With the help of the community, the work consisted first of re-profiling the slopes with terracing the slopes, following contour line. This was followed by planting of vetiver hedgerows on the terraces. Two hundred and forty days after planting, the vetiver plants reached a maximum height forming a very dense vegetative hedgerow. Degradation at the 3 ITPK ravine heads was completely arrested and slopes were totally stabilized against collapse and landslides. The vetiver technology showed to be a most effective and appropriate solution to stopping the progression of urban erosion.

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A Brief Introduction to the First Author

Mr Alain Ndona is a Civil Engineer, working for USAID's Congo Livelihoods Improvement and Food Security (CLIFS) project, a two year project implemented by a US NGO Innovative Resources Management. He has developed a VS for ravine stabilisation, which impacted on tens of thousands of people in two provinces – Bandundu and Equateur. His work covered one successful CLIFS initiative in Kikwit, a town of one million people in the principal food producing province of western Democratic Republic of Congo.