Restoring a dam sub – watershed using the Vetiver System – some observations and suggestions.

Photo: 1Photo: 1 Eroded left bank of Muchuki dam and top of weir in back ground

Introduction: Landscape restoration can be relatively easy when presented with an area under single ownership, but far more complicated when occupied and used by many different occupants with different land use objectives and attitudes relating to environmental matters. Combined, they may result in multiple activities that affect the watershed environment. The Vetiver System (VS) can mitigate, at low cost, some of the land, soil and water related issues, and it can achieve this through applications ranging on small to large land units, indeed VS can be effective even in small "fragmentary" forms of application. To restore an altered and degraded watershed to an improved level of improved functionality a community approach is most likely needed.

The Vetiver System's various applications could be very attractive to a community – its many attributes and its scale neutral uses makes interesting discussion for community members to chat about, and with its low cost it allows a hands-on participation of anyone who is interested in mitigation. Simultaneous action by all parties may not be possible or even needed. In most instances watershed land is in the hands of multiple property owners – all with different agendas and time horizons.

An interesting paper from China: "**Vetiver System for rural landscaping and countryside beautifying**" looks at vetiver for landscaping and beautification with links to its conservation and phytoremedial attributes. It should be possible to use this approach to clean up, at the point source, important erosion and effluent discharge events on residential and commercial sites as part of a community landscaping program – for example a small constructed wetland located on a residential lot could provide an eye pleasing green space, and at the same time treat household and septic effluent, provide habitat for birds and insects, and when cut at least once a year provide mulch for the vegetable garden.

The very preliminary plan discussed in this note was undertaken using Google Earth and image interpretation only. and some feedback from a preliminary visit by a local group. To prepare a workable plan more field visits are required, including discussions with the various landowners/users who reside in this 50 ha area.

The Problem: The reservoir/dam (a weir) at Michuki is silting up, overgrown with rushes and is contaminated with effluent from nearby coffee plantations and residential housing (both existing and planned). The dam and small reservoir, is one of a number of dams in the larger watershed located 15 km NE of Nairobi, Kenya, in Kiambu district (close to the Windsor

Photo 1. Google Earth imagery of sub-watershed. A similar image at end of this note can be enlarged for the detail.

Country Club). Immediately to the west of the sub-watershed catchment is Tim's (Windsor dam). For this planning exercise we will focus on the sub-watershed (catchment) that serves the area between Michuki and Tims dam.

Note what follows is entirely desktop review, one that will need significant revision.

The Sub-watershed (SW): See photo 1: The sub watershed is about 50 ha, comprising 17 ha of managed coffee (C1 & C2 shaded green), I ha of small farm cropped land parcels (CR1 and CR2), 3.5ha of land for restoration (R1 and R), 7.8ha of existing medium density residential development (RD2 shaded blue), 9.6 ha of planned and initiated new development (RD1 sshaded brown), Michuki dam reservoir (0.5ha), and the balance is mainly forest and 6 high value residential properties adjacent and immediately east of Tim's dam (13ha).

Mitigation activities: will depend entirely on what the land/property owners that make up this community are prepared to undertake. We assume that coffee estate and individuals and/or community partnerships will carry the costs and undertake the work. The philosophy will be to fix the problem at its point of origin (the point source), providing environmental, economic, and health benefits to the people who live in the area. Multiple point sources for sediment and effluent flows will be identified. There appears three main problem areas: (a) the coffee plantation (C1)discharging rainfall runoff, eroded soil and excess agricultural chemicals (fertilizer and pesticides) via unplanned or poorly designed/operated drains/tracks, such as B1, to the central stream that feeds Michuki dam (b) an existing residential area (RD2) that discharges untreated wastewater of different kinds and sediment via ineffective, sometimes non existing road drains, and (c) a new development area RD1 where serious erosion is

occurring as a result of partly constructed roads and unprotected land. In addition there are two small partly cropped area R1 and R2 that are eroding and need to be protected.

Specific Vetiver applications:

Photo: 3 Vanuatu (South Pacific - Vetiver planted on road shoulder and vetiver miter drains that discharge rainwater from road to adjacent land

Coffee areas (C1 and C2): most of the farm roads in the coffee area become drains in the wet season. Road R5 appears to be equivalent to a collector drain dumping water into downhill tracks like DR1 that discharge storm water into the stream supplying Michuki dam. These roads should be reformed with vetiver protected side drains that discharge rain-water back to the coffee planted areas.

Consideration should be given to introducing vetiver hedges into the coffee itself for soil and water conservation, mulching and soil temperature reduction. Where this is not possible then If and when old coffee is replanted, the replacement trees should be laid out on the contour and between vetiver hedgerows planted 10-15 meters apart – approx. 2m vertical interval - (4-6 rows of coffee between hedgerows). Benefits will include improved soil organic matter, chemical use reduction, pest reduction (vetiver provides nesting habitat for beneficial wasps), weeding reduction, improved soil moisture, slower and less concentrated rainfall runoff, reduced hot season soil temperatures, and less erosion.

Photo: 4 A couple of short hedges across the plot areas is all that is necessary.

Cropped area CR1 and CR2: Two small areas totaling about 1 ha cropped probably by

multiple persons. The simplest application would be to plant short vetiver hedgerows (1) as plot boundaries (2) across the slope for soil and water conservation. The main benefit would be production of biomass for mulching annual crops (maize and beans?) reducing erosion, improving soil moisture and fertility and other benefits as out lined in the coffee paragraph above.

Restoration areas R1 andR2. These two areas cover about 3.5 ha and appear eroded. The best approach might be to install contour vetiver hedgerows at 2m VI (Vertical Interval) and plant a perennial mix of fruit and other trees – to create a community food forest? Much depends on the ownership and what the owners want to do with the land.

Photo: 6 Land between the coffee estate and Michuki dam, eroding with some cassava planting

Photo: 5 Typical land that could be restored with vetiver hedgerows - agro forestry; best under perennial crops

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Photo: 7 Restoration - Vetiver hedges and perennial trees

Photo: 9 s Vetiver stream banks stabilization and buffer in Zimbabwe

Buffers B1 and B2. The combined length is about 1000 meters. These buffers on either side of the stream and Michuki reservoir should comprise three rows each spaced 0.5 m apart. They would act as a very effective filter barriers. Other strategically located buffers not always associated with streams can be planted at other locations to provide protection from upslope events such as extreme rainfall events or discharge from drains or contaminated fields. A buffer hedge could be combined with a road hedge along the road that runs along the lower side of the coffee plantation

Photo: 8 The long hedge on the left could be considered a buffer hedge (New Zealand-Keri Keri). It was planted under John Greenfield directions in 2004, this Google Earth image was taken in 2023 - a 20 years after planting, that was planted at correct spacing - 15 cm. apart.

Existing medium density residential area RD2: This area of about 10 ha drains into Michuki dam. It comprises approximately 30 lots, most with houses. Many are enclosed by walls, most have gardens of various sorts. It is assumed that untreated domestic water and sewage effluent is discharged to adjacent roads via leaky septic tanks and rainwater runoff systems are probably the main sources. The best approach would be to fix the drainage problem before discharged through the property wall. This could be done in three ways (a) creation of vetiver based rain gardens that would collect discharge from house gutters and household effluent (b) dedicated constructed vetiver wetland to treat effluent discharge from the residence septic system and other grey water discharges, and (c) a few across slope hedgerows (perhaps at least along the lower wall/boundary) that would help dissipate general rainfall runoff. Other carefully designed hedgerows for landscaping and beautification would add to treating surface flows from whatever source. The combination of these three applications would significantly reduce polluted effluent discharge to the road drains, to the latter's advantage. This "Computer model for treatment of small volume wastewater" and a presentation of the same, is an excellent guide for design. As a rule of thumb 150 vetiver

plants per household member planted as a block or hedgerow(s) is required. Some interesting ideas for a drainage program in Kigali Ruanda was developed and some testing was done.

The roads that service the residential area have deteriorated due to under-designed and non-

Photo: 10 -14 are vetiver applications on residential properties for the disposal of domestic wastewater. Top left a constructed wetland to treat tertiary sewage effluent from septic system; Top right landscaping with vetiver hedges provides beautification and privacy, can also treat surplus run off. Bottom left – constructed wetland for household effluent (Indonesia) Bottom right: a small evapotranspiration plot for disposal of domestic sewage water.

maintained drains. These should be upgraded. Vetiver could be planted along the edge of the roads preventing shoulder erosion and slowing the drain discharge velocity by using vetiver cross weirs at intervals in the drains. The drains will need to drain into some carefully selected collector drains that would deliver drainage water to a constructed wetland, probably located just upstream of the Michuki dam.

Photo: 15. Badly eroded and drained road in Michuki residential area

Photo: 16. Another poorly maintained road that takes discharge of effluent from adjacent properties

Photo: 11. This Michuki service road would benefit from trimmed vetiver hedgerows on either side

Photo:1 8. Vetiver can be used as dividers or borders on roads

Photo: 19. This roadside vetiver prevents sediment from entering the drain, reducing road maintenance costs.

New Residential area RD1. Approximately 10 ha area. The latest Google Earth imagery shows that this area, (probably converted from temporary small garden allotments) has recently been laid out with dirt roads with no formal drainage plan. There appears to be heavy erosion

and is currently likely to be the main source of eroded soil that is ending up in the dam. It is a good opportunity to incorporate vetiver into the area as described for RD2 above. The management of discharge from this area could be greatly enhanced by a collector drain to move water to a vetiver constructed wetland. In addition by planting a buffer B1 as part of riparian protection plan, the balance surface water runoff from the areas on either side of the stream could filter into the stream directly**.**

Vetiver nursery located W1. Should be located in the vicinity of the Michuki dam and be developed to provide vetiver slips for the program. It could eventually be converted into a wetland for drainage water discharged from the residential areas. A minimum of 0.2 ha is recommended. (see this presentation on vetiver wetlands)

Michuki Dam: The reservoir shoreline should be planted to vetiver -- 3 rows planted 0.5 meters between rows (and 15 cm between slip centers in line). It might also be useful to phase in overtime a floating vetiver pontoon program (demonstration and education) to help further improve water quality. NOTE: From Google Earth and images supplied it looks as though the dam wall is in the form of a weir and not an earth dam with spillway.

Phasing:

Most community projects take time to implement, especially where community cooperation is required and funds are scarce. So, priorities need to be set. For this sub watershed the following are listed in probable order of importance: (1) vetiver nursery development (2) establish Buffers B1 and B2 (3) Michuki dam protection (4) Coffee area C1 and associated road protection and drainage (5) RD1 road protection. In parallel with these priorities, meetings should be held with the residential owners of properties at RD1 and RD2 to identify some leaders who could start using vetiver for point source mitigation application demonstration located within their property boundaries.

Attached are: (1) a larger Google Earth image of the sub-watershed (note the contour lines (white) are at 2m VI. (2) An enlarged photo of New Zealand planting showing vetiver as part of a residential property (3) photos of drainage/gully protection and stream buffer in Fiji and (4) support vetiver planting data for Michuki sub watershed

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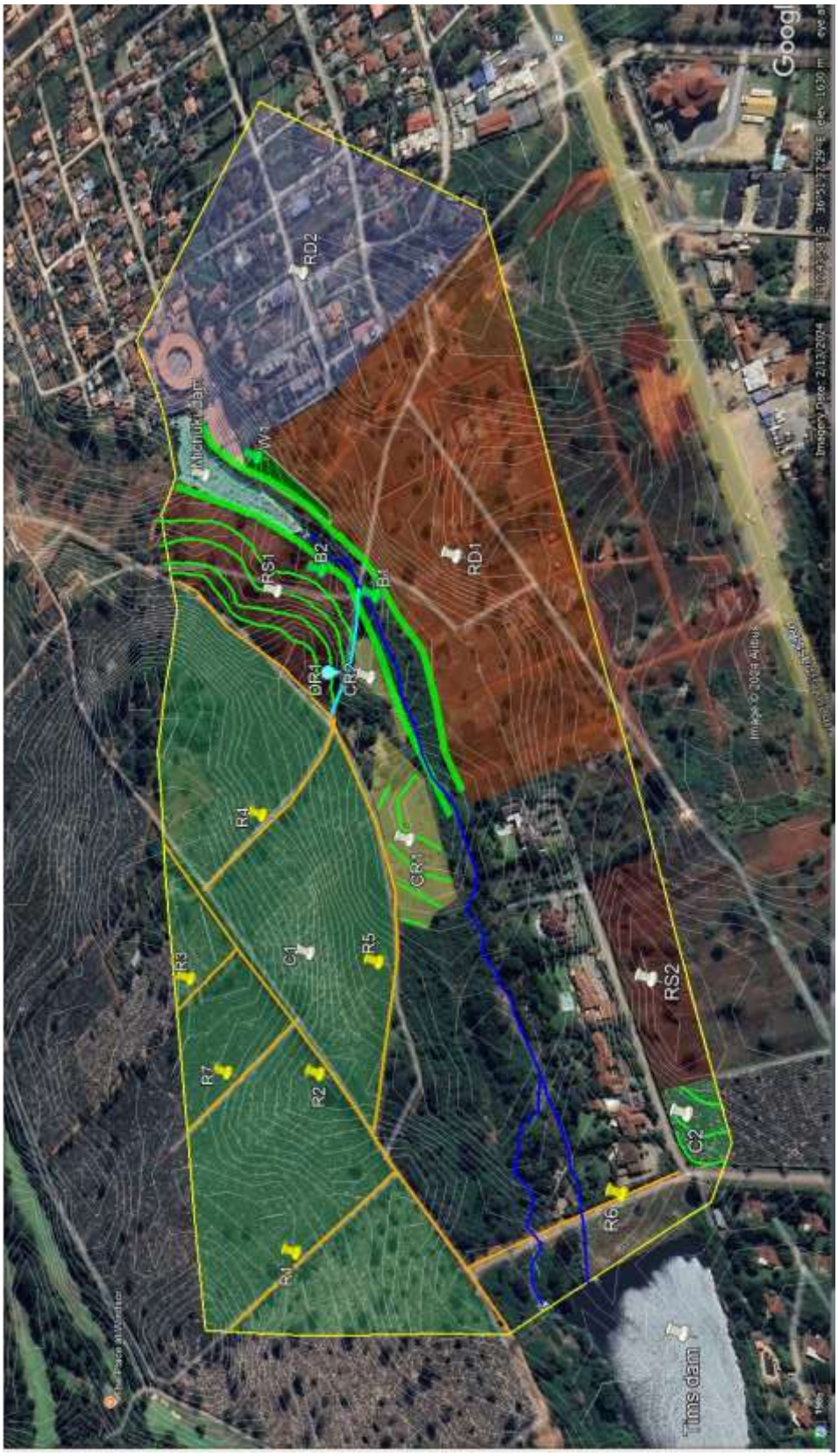

Michuki Sub watershed approx. 50 ha.

Yellow lines and spots show how vetiver has been used on this New Zealand residential property (yellow lines and dots point to some of the vetiver hedgerows)

Typical vetiver buffer hedge along drainage/stream bank - Fiji

Thirty year old Vetiver hedgerows protecting a major drainage way in Fiji

Michuki Dam Sub-watershed

	area ha	length m	% slope	Hedge seperation m	hedges per ha	total length m	# plants	Status	Possible actions
subwater shed	52								
Res dev1 RD1	9.6		8	24	4	3840	15360	Land in the process of residential developemnt - serious erosion and sediment movement to stream and Michuki dam	Road and drain shoulders planted to vetiver. In plot rain gardens, and hedges to act as absorbant buffers. CW for septic effluent
Res dev2 RD2	7.8						10000	Existing residential area mainly walled plots - drainage problems - sewage effluent	In plot rain gardens, and hedges to act as absorbant buffers. CW for septic effluent. As roads improve `include vetiver
Coffee1 C1	16.3		8	24	4	6792	54333	Established coffee - erosion and run off problems	initilallly focus on roads - vetiver miter drains to direct rainwater to coffee area. Thread vetiver hedgerows on approximate contours through coffee
Coffee2 C2	0.3		4	46	2	60	480	some erosion	initially 3 vetiver hedges would help
Cropped 1 CR1	0.9		10	18	5	450	3600	Cropped land in strips. Multiple users??	Short vetiver hedges across slope would provide protection and mulch
Cropped 2 CR2	0.2		1	Na		100	800	Crop land single user?	Short vetiver hedges across slope would provide protection and mulch

Restoration1 R1	2.4		10	18	5	1200	9600	partially cropped (multiple users)significant erosion discharged to Wichuki dam	Vetiver contour hedges - probably best planted tp perennial fruit trees - food forest
Restoration2 R2	1.1		6	20	5	550	4400	appears annually cropped, sediment discharge	Protect with vetiver hedgerows
Michuki dam dam protection	0.5						4000	dam siltatio. Farm and residential discharges	Surround dam perimeter with vetiver hedges to filter sediment and reduce efflent chemical entry. Add vetiver pontoons.
Woodland residentail below Tims dam	13						3000	High end well maintaine properties.	introduce rain gardens for effluent disposal
Tims dam protection							6000	appears stable and trouble free	check spillway and discharge issues, where necessary reinforce with vetiver
Wetland W1 nusery	0.2						12000	New nursery	potential site close to Michuki dam, could have dual purpose ues as a wetland to receive runoff drainage from RD 2 area
Sub-Total	52.3						105573		
Drain DR1		124					1984	track/drain with run off andprobably large sediment load from Coffee area C1	needs modification and miters drains leading to vetiver hedgerows in restoration area R1
Road 1 R1		265					4240	Coffee area road - unpaved	vetiver miter drains distributing road runoff back o to coffee planted areas. Road shoulders plant to vetiver
Road 2 R2		564					9024	Coffee area road - unpaved	ditto
Road 3 R3		102					1632	Coffee area road - unpaved	ditto
Road 4 R4		230					3680	Coffee area road - unpaved	ditto

Road 5 R5	636	10176	Road below Tim's dam	ditto
Road 6 R6	227	3632		
Road 7 R7	175	2800	Coffee area road - unpaved	
sub total coffee roads	**2323**	37168		
RD1 roads total	2400	38400	Currently heavily eroded due to unfinished dev.	All new roads and drains should be protected with vetiver
Total rds	4548	72768		
Buffer BUF1 B1 (3 rows)	540	11340	Stream	Both sides of stream should have vetiver buffers (three rows each side) to reduce sediment entry and act as filter for toxic metals etc.
Buffer BUF2 B2 (3 rows)	486	10206	Stream	ditto
Total vetiver plants		211887	estimated vetiver plants (slips) required	each slip should have 3-4 tillers and when planted as hedgerow should be planter 15cm apart.