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Full Length Research Paper

Gold panning and runde river course morphology in Mwenezi: A quest for a sound catchment management and sustainable development

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Land and natural resources remains the backbone of life and adaptation for most populations in Africa. Despite the Mines and Minerals Act 1996 as legislation in mining sector in Zimbabwe, there is continued adverse degradation of water resources due to illegal gold panning. Unprecedented changes in river morphology due to panning have negative ripple effects on aquatic life and the riparian. This study analyzed the impact of alluvial gold panning on river channel, focusing on depth, width, bad and channel features and its implication on sustainability of environment and water resources in particular. The study used both qualitative and quantitative research methodologies. Observational field work, measurements, photographs, archival research, interviews and questionnaires were used in this research. The river channel morphological changes have been caused by traditional sand wash, horizontal tunneling and the vertical pit method. These alluvial gold panning methods have resulted in reduced water velocity due to sediments deposition on river bed, processing of gold using mercury affected river bad rock and are lethal to plants and animal .Deposition of both course and fine materials narrowed the pools, siltation reduced carrying capacity of the river making it unsustainable for domestic or industrial purposes.Undercutting of the river banks resulted in vegetation loss, erosion and widening of the course. Deepened river channel threatened the stability of the river channel near the banks, settlements and farmlands. This is actually a ticking bomb for water resources sustainability. Therefore responsible authorities should established community area management of the river profile especially in rivers that are resource endowed like Runde for monitoring and evaluation.

Keywords: Alluvial gold panning, river morphology, catchment, sustainable development

BACKGROUND

Land and natural resources remains the backbone of life and adaptation for most populations in Africa. Gold panners have invaded much of the Central Highveld and along major rivers in Zimbabwe. Gold panning is divided into two categories, the 'illegal' and legal. The illegal gold panning is informal and not registered to the government. The legal is formal and the panners have been issued gold panning permits by the Ministry of Environments and Tourism (Allardice, 2009). Illegal gold panning has now reached unprecedented levels, hence, this environmental problem currently need attention to avoid disaster to both

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the biophysical and human environment (Gandiwa, 2006). To alert the stakeholders, this study is based on illegal gold panning along a channel section of Runde River, that there could be tremendous changes due to panning activities. The channel changes would have an impact on the riparian zone. Maponga (2003) has been more concerned with the influence of panning upon environment. This study will further elaborate how panning activities impact on the river channel, focusing on the depth, width, deposition and channel features. River bed alluvial gold panning activities are a cause degradation of river channel as well banks, (Zwane etal, 2006). The study need to undertake the measurement aspect to form a scientific base on evidence of gold panning activities influencing river channel changes. Ideas concerning implementation of environmental procedures would be drawn to forefront with numeral values for planners to know which part of the river are affected by panning activities.

On many occasions, environmental conservation and protection measures are taken as a reaction to address the problem when they are at their worst (Sibanda, 1996). As such this study seeks to alert responsible authorities of Mwenezi District of the looming disaster at Chitanga Area, ward 1 due to illegal gold panning activities.

The alluvial gold panning activities are not a monopoly of Zimbabwe rivers, but were also rampant in the Niger, Nile and the Amazon River. Rivers are essential to support human life and aquatic ecosystem. They provide fish, transport and alluvial farming. Information on river behaviour in response to alluvial gold panning can be used to take appropriate measures to conserve ecological riverine and rehabilitation of the channel. We have a heritage to protect for future generations. Indeed, we should be prepared to endure pain as we undergo a phase of self-correction and restoration of discipline in environmental management sector. Sibanda, (1996) points out that each stage of gold panning is associated with some form of environmental effects. Research on environmental impacts of gold panning on the environment has found the siltation of dams, rivers but do not further look at the river channel and its features changes due to alluvial gold panning.

Hard pressed by economic straits, illegal panners are tearing up Zimbabwe's river in search of gold. They leave behind a trail of destruction, devastated field and forest, muddy choked river and mercury tainted water. The 19th century style of gold rush has take place in Zimbabwe's ten provinces. Rivers are filled with silt, harming ecosystems as well as farming, fishing and water. Panners use mercury and cyanide to separate gold from ore and then flash toxic in the rivers. Environment and Tourism Minister went a step further telling reporters 'If the illegal mining is not stopped, it could turn the whole country to rubbles in the next few years.'(MET, 2004) The study of Chitanga area, a channel along Runde River, gives the opportunity to study human influence on fluvial landscapes. Alluvial gold panning activity is the human activity under study, to establish changes to the river channel.

OBJECTIVES

- To identify the alluvial gold panning methods in Runde River that affects the river channel.
- To demonstrate channel changes that occurs on river channel due to panning.
- To recommend measures to avert channel disturbances for sustainability in gold panning.

STATEMENT OF THE PROBLEM

Gold panning has increased in Zimbabwe's major rivers as such that the study seeks to establish the impact of increasing alluvial gold panning activities on river channel.Persistant dilapidation of the river channel has been a cause for consent in Chitanga village. Channel change has been realized to have an immense impact on livelihood on the riparian zone, a challenge that has far reaching impacts on the welfare of the innocent chitanga households. The study would complement the previous studies, establishing how alluvial gold panning had changed the channel. This will provide us with a key on how human beings transform the present channel through panning. Knowledge of river channel is useful for construction of dams, weir and bridges. Alluvial gold panning had negative impact on all development projects. Study of rivers in reaction to gold panning activities is assumed to form new platform in the study of channel features. The study stimulates a strategy of environmental protection before problem reaches is worst (Arnthzen et al. 1996). There is need to secure knowledge on the impact of alluvial gold panning on rivers for sustainable use of water resources.

CONCEPTUAL FRAMEWORK

The History of gold panning

Gold panning is an ancient practice dating back to the 12th century (Alphonce, 1994). In Zimbabwe, gold panning was done back to the Karanga and Manyika Kingdom (Mahlungu, 1992). The spreading continues even after independence along 5000 kilometers of Zimbabwe's' major rivers, including Mazoe, Angwa, Insiza, Runde and Bubi River. Nationally, the worst affected areas are Mazoe District, Kadoma District, Makonde District, Kwekwe District and Gutu District (Choropleth map Figure 1 showing District worst affected by illegal gold panning (DNR 2005). These districts are along the Great Dyke which is richly endowed with gold

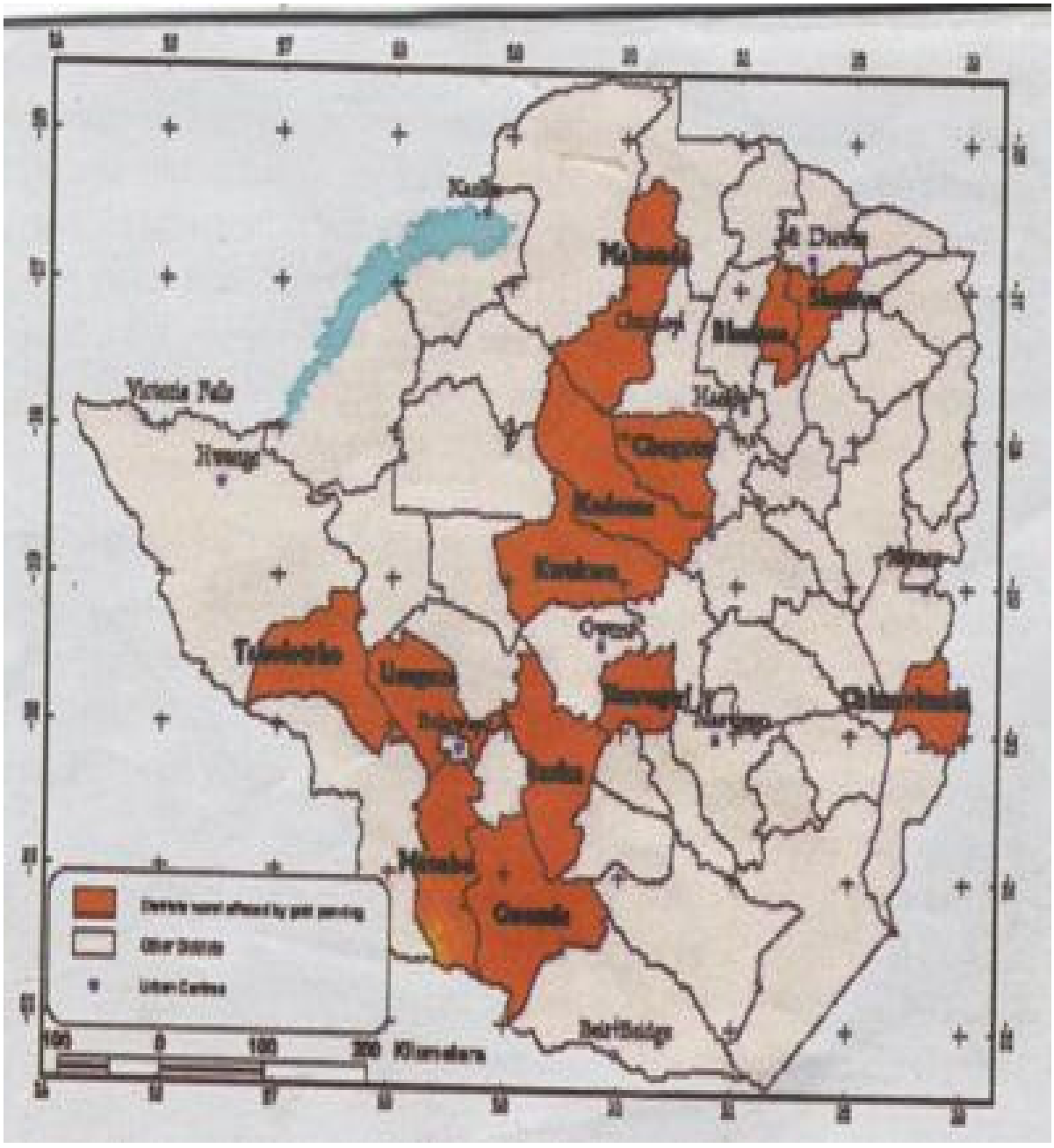

Figure 1. *District worst affected by illegal gold panning (Source DNR, 2005).*

and other minerals.

Alluvial gold panning activities are not a monopoly of Zimbabwe as Holloway, (1996) found out that other countries like Burkina Faso and Tanzania face similar problems. A study of channel section of Runde River would be used to reflect that Runde River is one of the rivers affected by alluvial gold panning in the history of gold panning.

Methods of Gold panning

River bed gold panning is the extraction of gold from river bed itself and alluvial gold panning is the extraction of gold from the banks of the river (Chenje, Sola and Pateczny 1998). The panners dig both the beds and the banks of the river and this negatively affect the channel. The grains of gold are weathered from hard rocks,

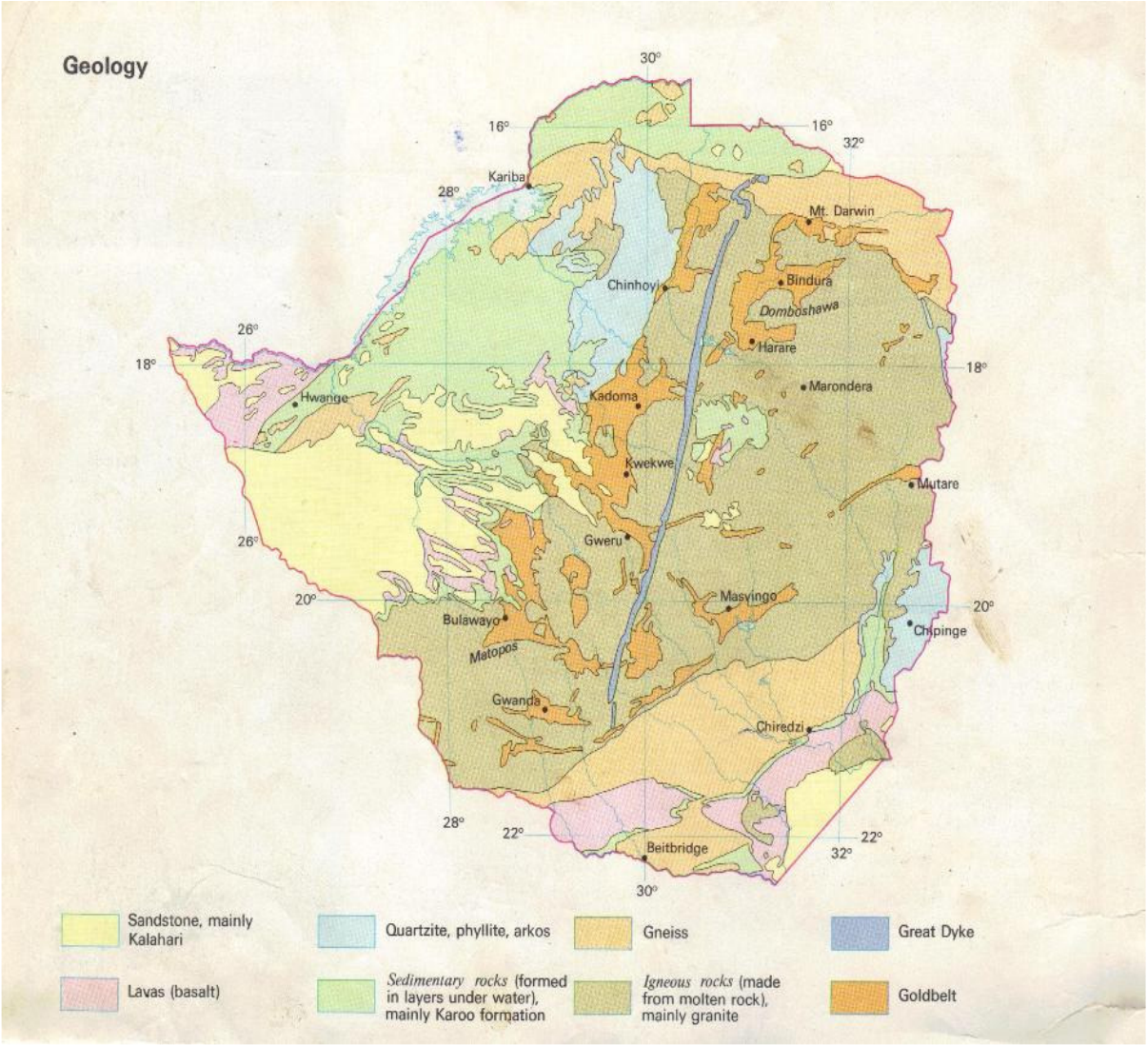

Figure 2. *The distribution of minerals in Zimbabwe*
Source: *School Atlas for Zimbabwe, 1990*

eroded downstream and deposited in the river. The grains accumulate and form fluvial deposits. Deposition that occurs away from river channels is known as reef. Any form of gold deposit within the river channel is termed alluvial (Mahlungu, 1992). The existence of the gold belt in Zimbabwe suggests potential alluvial deposits in Runde River which originate from the Great Dyke of Zimbabwe near Gweru. A Geological map of Zimbabwe in Figure 2 shows the distribution of minerals in Zimbabwe (School Atlas for Zimbabwe 1990).

Panners use several methods to extract gold grains from the river beds and banks. Among the three widely used are the horizontal tunneling method, Traditional sand washing method and the vertical pits method. The horizontal tunneling method resulted in undercutting of river banks (Chenje et al. 1998). The panner digs the banks of the river and creates tunnels like drift mining methods. During heavy rain, the river banks often collapse, causing vegetation loss, erosion and siltation of rivers. Traditional sand washing method is panning method where exposed gravel in the river beds are placed in a pan and are left over brim a few sediments at a time into the river. It is assumed the activity resulted in large sediment load in the river. The vertical pit method involves the digging of pits on the river beds and banks. Huge material is thrown away after extracting the alluvial gold deep pits are left open. In panning the bed rock is never reached in most cases because of the poor equipment (Holloway, 1996).

Table 1. Gold Panning activities for 1992 and 1997

Province	Number of rivers and wetlands	Number of rivers with panning		% of affected rivers	
		1992	1997	1992	1997
Mashonaland Central	311	15	17	4.8	5.5
Mashonaland East	474	10	16	2.1	3.4
Mashonaland West	45	14	6	31.1	13
Matabeleland South	133	15	0	11	0
Matabeleland North	286	1	0	0.3	0
Masvingo	105	10	0	9.5	1.2
Manic land	243	6	3	2.4	0
Midlands	392	15	0	4	0

Source: *Chenje etal, 1998*

The Channel Shape

The channel shape is best described by the term hydraulic radius that is the ratio between the area of cross section and the length of the wetted perimeter. These characteristics or parameters include depth, width and channel roughness. Channel cut in solid rock change only slowly with time, but those composed of river alluvium adjust rapidly to changes in water flow (Bryant and Richard 1986). Human activities such as damming, irrigation, channelization and alluvial gold panning are such activities which can influence river adjustment. A change in depth, width, slope, channel roughness can be beneficial or impact negatively on human life. Rivers are natural resources they must be conserved and protected at the same time. For sustainable utilization of resources, river channel warrant study.

Alluvial Gold Panning Activities in Zimbabwe

Having looked at the river channel, it is now necessary to proceeds by looking at the activities that transform the river channels in Zimbabwe. A brief explanation on the benefits of gold panning will be followed by the environmental and socio-economic impacts of gold panning in Zimbabwe. In Zimbabwe panning activities are either perennial or seasonal (Maponga 2003). It is estimated that over 600 000 people are directly involved in gold panning along the major rivers. Gold panning is done in all provinces in Zimbabwe (Table 1 shows Gold panning activities in 1992 and 1997 (Chenje et al, 1998).

The figures for 1992 cover both illegal and legal panning whereas for 1997 are for registered panners only. From the table1, above gold panning is not widely done in Matabeleland North Because Of Dry Condition Prevalent in the Area. The Problem of Panning Increased To Supplement Food Supplies By Rural Residents. There Is Increase In Gold Panning Due To Tough Economic Conditions Include Loss Of Jobs Due Global Economic Crises, Poor Agricultural Yield Due To Successive Drought. Runde River Is No Exceptional Among The New Gold Rush In Masvingo Province.

Environmental Regulations and Gold Panning

Maponga (2003) and Holloway (1996) have been more concerned with the influence of panning upon the environment. The studies showed that gold panning produce sedimentation and cumulative of sediment in rivers, dams, weirs. A 1992 report by the Department of Natural Resources suggested that half of the country's dams are silted. It was no longer economic to construct new degraded river bed since they slow down the rate at which the river discharges and develops a surface flow after the rain. This problem is due to the myriad of excavated tunnels, trenches and holes, which must fill up first. The presence of chemical like mercury, which is used extensively in gold panning activities, has severe and far reaching consequences for riverine ecosystem. It is estimated that annually, gold panners use six metric tonners of mercury (Gandiwa 2006). Mercury pollutes the water and is risk to human health and aquatic life.

Under the Water Act, sub-catchment and catchment councils are responsible for the sustainable management of water resources within their management areas. These responsibilities are mainly within the context of IWRM planning for the catchments, and can sometimes bring them into conflict with certain economic activities that cause damage to the riverine environment. However, resolving such conflicts is essential to prevent river system degradation and the resulting reduction in use options for available water (Falkenmark, 1998). In this context, Zimbabwe has developed legal instruments designed to empower local authorities to control and regulate gold panning. Specifically, it is the responsibility of Rural District Councils (RDCs) to enforce SI 275 (Mining (Alluvial Gold) (Public Streams) Regulations of 1991). Panning operations are accompanied by massive damage to river systems. The hydrological system, and the ecosystem that it supports, are negatively impacted by physical and chemical damage. Physical damage includes the digging up of river channels, banks, paleo-

channels and their flood plains as well as surface trenching using picks and shovels, resulting in hazards for humans, domestic and wild animals as well as reducing river frontage (Shoko and Love, 2005,Zwane etal ,2006). There is widespread deforestation, as vegetation is cut down to provide fuel for use while panning (Shoko and Love, 2005 Zwane etal, 2006,). The regulations include a number of provisions to counter the negative effects of panning, including that operations shall be confined to the bed of the stream and at least 3.0 m from either bank, trenches to have a maximum vertical height of 1.5 m where there is no terracing or sloping and mined areas within stream beds shall be rehabilitated by back-filling at the end of the operation. Proposed revisions to the regulations build out and expand substantially the participatory element. If implemented, the proposals would give the ordinary rural resident a direct role in controlling the impact of riverbed mining on local rivers (Shoko and Love, 2005, Zwane etal, 2006). Catchment Councils are required to consider rivers as vulnerable, finite resources and manage them sustainably through the catchment outline plans, but their powers are limited with regard to mining operations. Section 61 of EMA also provides for the establishment of environmental committees who have to prepare an Environmental Action Plan for their area of jurisdiction. Environmental committees are supposed to recommend to council, measures of management, protection of the environment and ways of implementing environmental measures then prepare and recommend plans required in terms of the Environmental Management Act (Section 133). The more reactive provisions to counter the environmental impact of gold panning include stiff penalties for pollution of water in contravention of water quality standards, the provision for orders to preserve or protect a watercourse, including beds and banks or to prohibit or restrict the excavation of sand and gravel.

RESEARCH METHODOLOGY

This research study uses descriptive case study method which allows for both qualitative and quantitative paradigms. The target population is a sample of five sites where alluvial gold panning is done in Runde River. The area is divided into 3 parts, namely upstream central and downstream. The upstream comprises of site A and B, the central site C and D and downstream site E. The sites are at least one kilometer apart to allow meaningful changes on major aspects. The target population of at least five panners from, each site was identified. Structured interviews were conducted with key persons including officials from Mwenezi Rural District Council water authority staff. A questionnaire guided the interviews with key informants. The key informant interviews were meant for a situational analysis of the involved sectors. The questionnaire investigated how the interviewees perceived the management of gold panning and how they viewed its effects and how its effects channel morphology. Interviews with gold panners and local water users were also done to solicite how the feel about channel morphology. Respondents were selected using convenience sampling because gold panners are known for hostility, violence and fleeing due to the fact that their activity is illegal in the Runde catchment area. Ward councilors helped in identifying respondents. Staffs from Zimbabwe Republic Police in Runde were interviewed to identify gold panners. The interviews aimed at obtaining data on how people conducted the activity to determine compliance with EMA. Field observation was undertaken along a 5kilometre stretch of the channel under study in assessing the changes in depth, bank, and width of the river. Photographs of present features were taken during the fieldwork. Features such as pools, channel bars and potholes were photographed to show how gold panning activities affected the channel features. The width measurement on all sites was taken using a tape measure. The depth measured using a metre rule and a tape measure. Features like potholes, pools braids and channel bars were recorded and measured. A map for Runde Drainage Basin was obtained from the Zimbabwe National Water Authority (ZINWA). The geological map of Zimbabwe was used to study the rock type which Runde River cut across (School Atlas 1990, Figure 2). Excel and content analysis was used in presentation and analysis of data.

STUDY AREA

Figure 3 shows the drainage basins of Zimbabwe and Runde catchment as the study area in the south eastern region of Zimbabwe.

RESULTS AND DISCUSSIONS

Methods of Alluvial Gold Panning

The illegal gold panners operating in Runde River uses three methods of extracting alluvial gold. These are the traditional sand wash, the horizontal tunneling and the vertical pits method. Some photographs of the methods and the site where it was done in Runde River were illustrated.

- Traditional Sand Washing Method

Figure 4, 5 and 6 shows how the sand wash methods impact on the river channel

Figure 4 shows a sand washing method of extracting gold from the river bed. Sediments materials are placed in a pan and are let over the brim, a few sediments at a time into the river. The process is repeated several times until large sediments are deposited in the riverbed. This results in the siltation of river which reduces the velocity

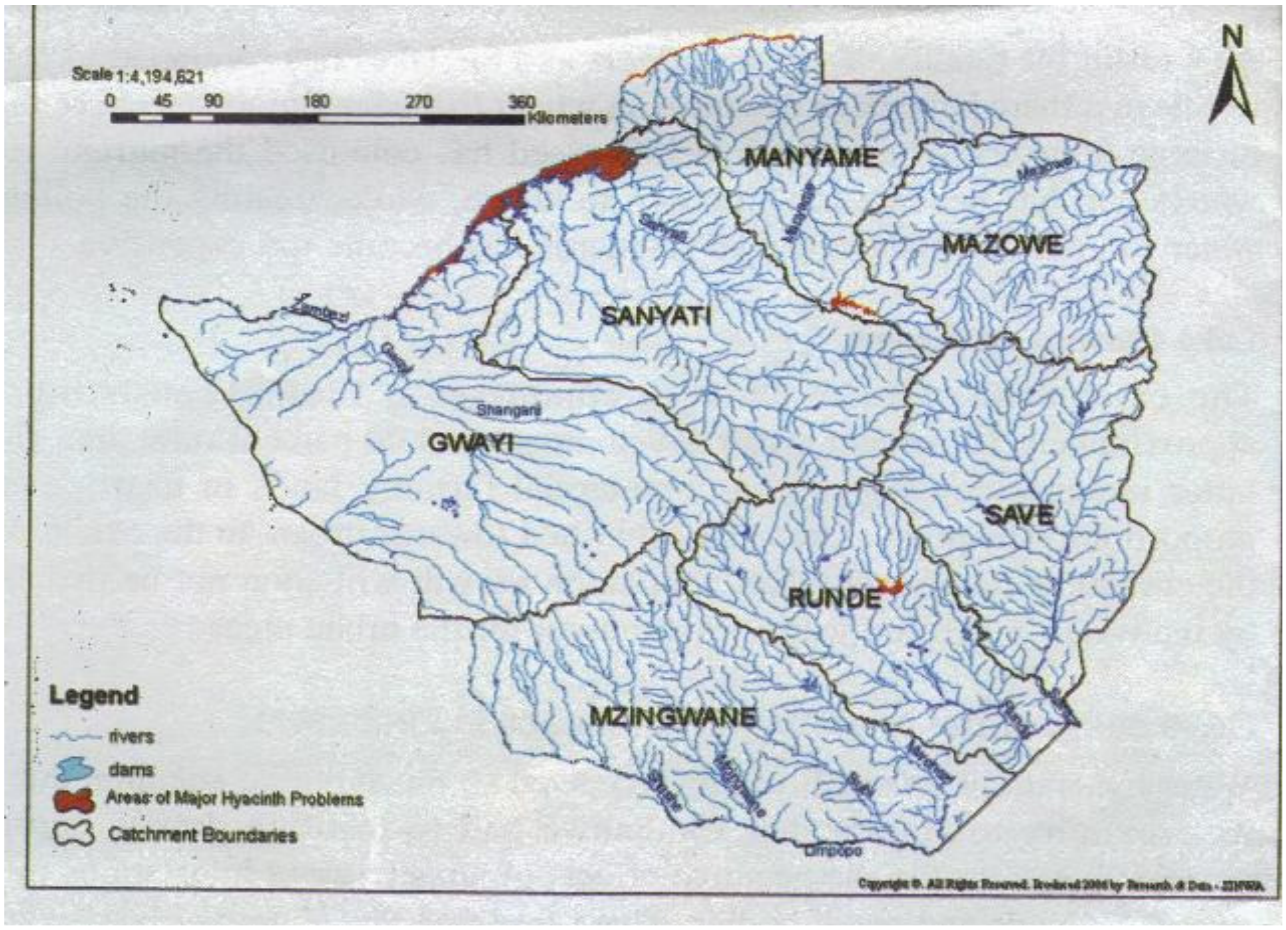

Figure 3. *Drainage Basins of Zimbabwe*

Figure 4. Traditional *Sand Washing Method*

Figure 5. *Traditional Sand Washing Method*

Figure 6. *Traditional Sand Washing Method*

of the river.

Figure 5 shows the sand wash processing equipment. The panner on the photograph is further processing alluvial gold using a plastic dish. The fine silt is deposited in the river bed causing siltation. Further processing ofgold using mercury which is extremely toxic chemical, affect biodiversity and human health. When mixed with water, mercury is lethal to plants and human beings.

Figure 6 shows a fairly narrow deep pool at site B in Runde River, the average pool at depth 1,3m and an average diameter of 15m. The pool had been heavily polluted, it comprises of muddy water due to intense panning activities. The deposition of course and fine materials further narrowed the pool. Induced siltation has further reduced the water carrying capacity of rivers and making it unsustainable for domestic or industrial purposes.

- The Horizontal Tunneling Method

The tunneling method is another method practiced by illegal gold panners operating in Runde River. The panners dig the banks of Runde River creating tunnels as shown on figure 7 and 8 below.

Figure 7. *The Horizontal Tunneling Method*

Figure 7 shows that the horizontal tunneling methods have resulted in under cutting of river banks. During heavy rains, the banks often collapse causing vegetation loss, erosion and siltation of river. These activities result in river widening thus increasing its width. The tunnel shown is of length 1,5m and a diameter of 1m.

Figure 8 a tunnel of length 4m and a depth of 1,5m. The panners dug the river bank widening and deepening the channel. Man made pools of the average depth of 1m and 18m diameter was dug by panners. This had deepened the river channel and threatens the stability of the river channel near the banks.

- The Vertical Pit Method

The panners had dug the Runde River bed leaving deep pits as shown on figure 9a, 9b, and 10

As a result of the pit method figure 9a reveals the further outcomes of extraction of alluvial gold. The river channel had deepened and depositing sediments on the river bed. These man-made pot holes are a danger to livestock's and human being.

Figure 9b shows that the deep pits created by gold panners may also force a river to change course resulting in the formation of features like the ox–bow lakes.

Figure 10 shows panners can dig pits of average depth 1.5m and diameter 15m. The vegetation which helps to stabilize the river channel has been destroyed. The pits widened the channel affecting animals which live in the channel banks. Tracks which link Chivi and Mwenezi District had been destroyed. The river forced to change its course threatening settlements and farmlands. Thus, it affects agricultural production in rural areas.

Observed trends and features

Table 2 shows that panners were destroying the banks or bed of the river. Their destructive activities resulted in the formation of man- made pools, tunnels, pits and pot holes. Recent heaps of sediments were forming new braids at the panning area.

Figure 8. *The Vertical Pit Method*

Figure 9a. *The Vertical Pit Method*

Figure 9b. *The Vertical Pit Method*

Figure 10. *The Vertical Pit Method*

Table 2. *Sites sampled for analysis along the river*

Site	Width	Depth	Observed Features and Panners Activities
A	150	18	Large pools with large siltation occurring. Man-made potholes and piles of sediments. Panners digging the river bed leaving large pits.
B	200	16	Very deep pools and some pools are filled with sediments. The gap between builders and cobblers were heavily clogged by course sediments. Panners digging tunnels on the river banks. Heaps of fresh sediments deposited.
C	300	17	Panners destroying old braids and new ones forming. Builders and cobblers were heavily clogged by fine and course sediments.
D	250	16	Fairly large pools with siltation of recent sediments. Fairly clogged cobbles and boulders. Panners extracting alluvial gold deposited between boulders.
E	250	12	Large man made pot holes. Heaps of old sediments. Silt deposited on old pits.

Source: *Field Work, 2013*

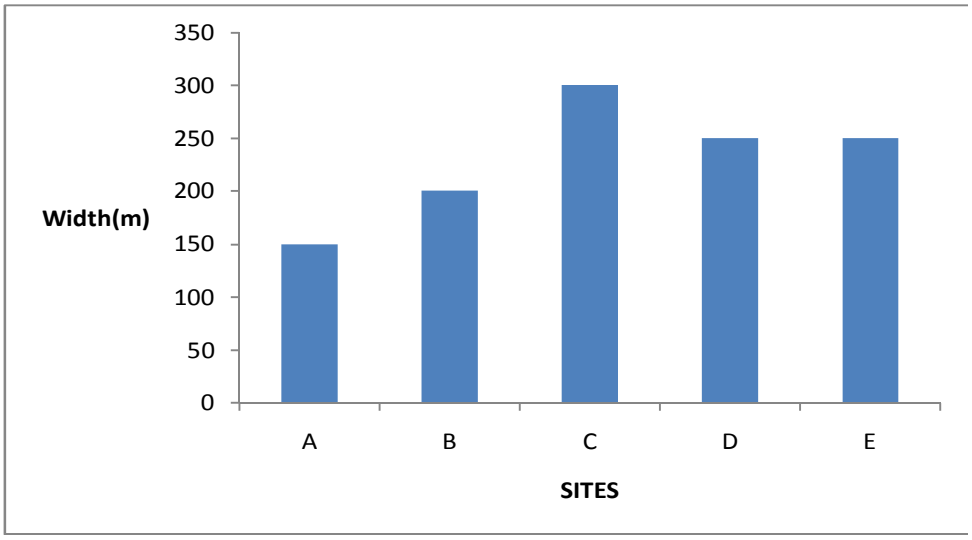

Figure 11. Width Measurements and Variation

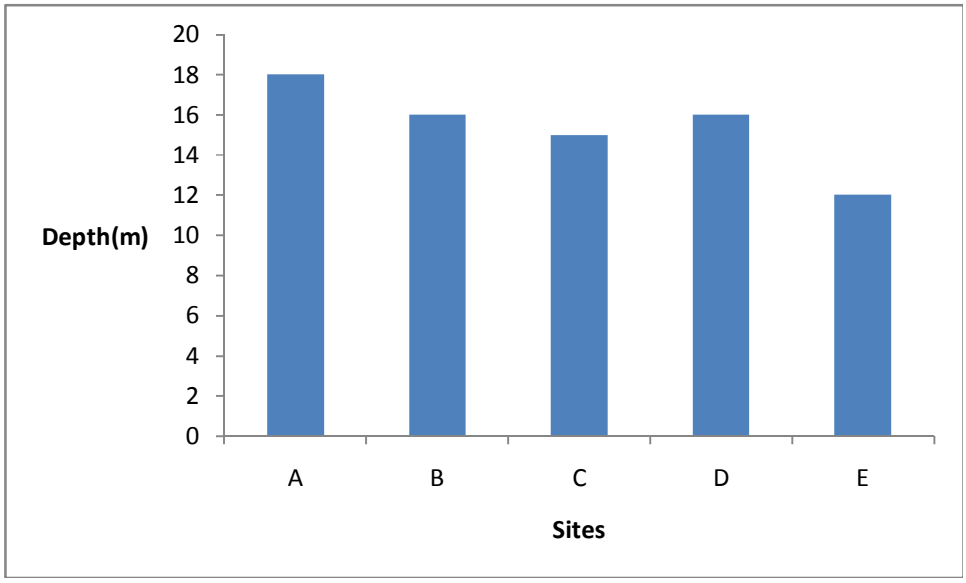

Figure 12. Depth Measurement and Variation

Width Measurements and Variation

All sites are situated downstream after passing Runde Bridge which is approximately 100m long. Site A is 150m, Site B 200m, Site C 300m and Site D and E 250m wider. At site A the width of the river is fairly wider because panners are not very much active on the river banks in this zone, probably due to its proximity to Runde Bridge so panners are afraid of the police and EMA who can arrest them for illegal gold panning. There is an increase in channel width at site B, C and D with the longest width at site C where the channels are braided. Intense panning activities are characteristics of these sites. At site E the width tends to be wider, which is also evidence of past extraction of gold on the banks of the river.

Depth Measurement and Variation

The depth decreases as one moves downstream from site A to site E. At site A average depth is 18, B 16, C 17, D 16 and E 12 metres. There is an increase in depth at site B and D where there are many panning holes. The depth decreases at site E where deposition is occurring in the old panning holes. It was observed that panners extended their gold panning activities on the beds and banks of rivers. The deep prospecting activities on the river beds enlarged channel depths and panning activities on the bank widen the river valley. Runde river channel is deepening to a depth more than fifteen metres on other parts. The valley is widening to length three times Runde Bridge. Had it not been the influence of alluvial gold panning, the Runde channel would be relatively uniform. The irregular widening of river channel is attributed to alluvial gold panning activities.

Alluvial gold panning activities impact negatives on the Runde River channel resulting in the formation of man-made features making it difficult to identify natural features. Pools existed at all sites, but at areas of intense alluvial panning there were man-made pools being created. Natural pools were deepened and enlarged by alluvial panning activities resulting in the siltation of some pools on the other part of the river being forced to change course as evidenced by existing braids along the river.

A discussion with panners yield valuable information on the historical changes on the river channel since the beginning of alluvial gold panning activities along Runde River. The panners displayed knowledge on environmental degradation caused by panning activities. They had observed the channel changes in depth, width and features. They also displayed knowledge of siltation occurring in some parts of Runde and the impact of chemicals (mercury) they use to the aquatic ecosystem and human beings. However, in justifying their reason for gold panning, panners concurred with Sibanda (1996) that they were hard pressed due to perennial drought which had hit the area for the past decades. Panners lamented the impact of climatic change which had turned the areas into a drought prone area.

CONCLUSIONS

Alluvial gold panning activities operating in the Runde River channel are accompanied by massive damage to river system. The hydrological system and ecosystem that is supported are negatively impacted by the physical and chemical damage. Physical damage includes the digging of river channel, banks and pale channels and their flood plain. Surface trenching using picks and shovels, resulted in hazard for human domestic and wild animals. The widening of Runde River channel reduces energy with the river. It has been observed that the channel is deepening at other point and widening at an alarming rate. This calls for all stake holders to manage the water resources. Variation in width, depth, sediment and observed features indicate the changes that had occurred in the river channel. Panning loosen river bed material and make it prone to river erosion thereby deepening the channel. The collapsing of tunnels on the banks of the Runde channel widens the channel laterally. The panners destroy old features leading to the construction of new ones. Agency (EMA), The Ministry of Environment and Tourism and the Mwenezi District Council together with law enforcing agents should enforce laws which would maintain Runde River stable. The statutory Instrument 275 of mining (Alluvial gold in public streams) must be implemented and punitive measures for those who engage in illegal gold panning operation should be enforced. With greater public participation, it would be more persuasive as they would feel responsible, accountable and have community sense of ownership. Once the spirit of togetherness is forged, the greater cohesion, integration and coordination of economic activities, conservation and protection of our river channel would be achieved. The responsible authorities should persistently carry out an Environmental audits. EMA and other authorities should make an inventory list of resources, which is continuously monitored to control activities that cause environmental degradation. Local communities are encouraged to divert from gold panning activities and engage in projects such as conservative farming, poultry, building, welding and other cooperative which can make them survive without harming the environment. Communities should take advantage of rural electrification as an opportunity to engage in other income generating projects. For sustainability of our river resources there is need to embark upon sound environmental programmes conserving and managing our rivers. Unless we act as good stewards today future generation will suffer because of illegal gold panning activities which are destroying our rivers. This is a ticking bomb for water resources sustainability.

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