The challenges, opportunities and future prospects of alluvial mining in Panguna

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Abstract

Panguna mine was a major copper-gold producer, operating from the early 1970s to the 1990s. During its operational life, the open-cut mine boosted government revenues unparalleled by any mining operation in PNG, even by today's standards. An abrupt turn of events saw the demise of the mine against the backdrop of a civil war between the indigenous population and government forces. The ten-year long civil war resulted in many deaths, chaos and the destruction of infrastructure. Decades on, regrowth of the vegetation has reclaimed the cloud eclipsed Crown Prince Range, where the open cut mine was hosted. Today, on the fringes of the abandoned mine, alluvial miners congregate, often seen working from dawn to dusk panning for gold. This paper previews the challenges, opportunities and future prospects of alluvial mining at Panguna viewed through the development theoretical paradigm.

Keywords: Alluvial mining, Panguna mine, BCL, referendum, economic sustainability, development aspirations, political future

Introduction

The citizens of ARoB (Autonomous Region of Bougainville) will vote in a referendum on 19th June 2019 to determine the political future of the region. Whatever outcome emanates from the referendum, economic sustainability for ARoB is essential to position the developmental aspirations going forward. It would be interesting to understand if the alluvial gold mining sector can be economically integrated as an invaluable component for social and economic sustainability of ARoB. This

research sought to identify and understand among other things the economic feasibility of alluvial mining operations by the indigenous population in Panguna. The following map of ARoB (Figure 1) shows the location of the now abandoned Panguna mine. A brief rationale for conducting this research follows the map (Figure 1).

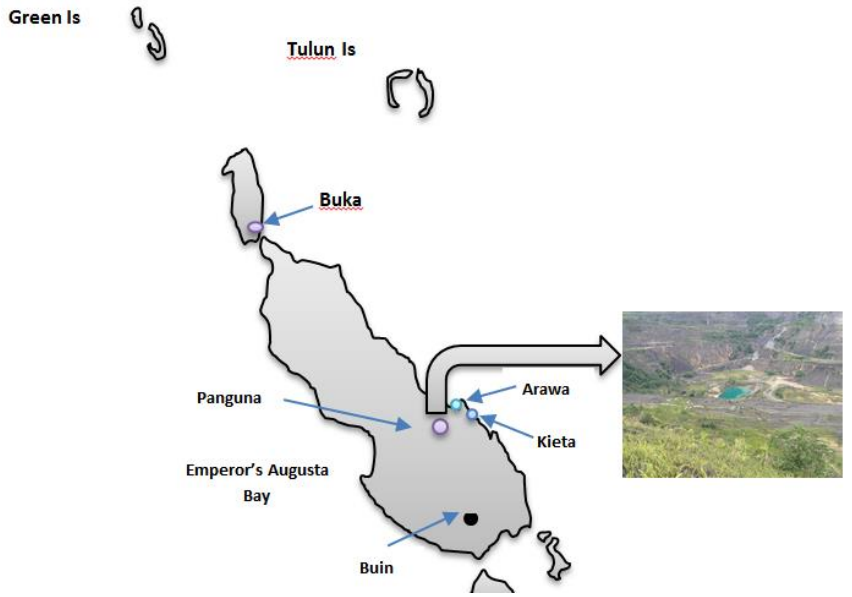

Figure 1: Map of ARoB showing the research site: The abandoned Panguna Mine in the Crown Prince Range on Central Bougainville range (Source: Author).

Understanding of alluvial mining in Panguna was sought with the hope that doing so may uncover the factors and determinants required to support, improve and incorporate alluvial mining into the economic structure of ARoB. The convenient integration of alluvial mining into the overarching economy could have beneficial outcomes such as skills transfer through training and support including the formal recognition of the industry, in a previously war zone area. This research is a contribution towards literature on alluvial mining in both ARoB, particularly in Panguna and Papua New Guinea (PNG). It also adds to the body of knowledge on alluvial mining in PNG, one of which is discussed next.

Mek (2011) investigated the 'Meriyak alluvial Gold mining' and concluded that whilst alluvial mining brought employment and income, crude operating techniques were detrimental to both the miners and the environment. Despite this, the government has recognised the sector as making an important economic contribution to the unemployed rural population and has enacted the supporting legislation. The study by Mek (2011) called for a model to combat increasing environmental damage caused by alluvial mining whilst concurrently stimulating the healthy growth of the sector. This paper seeks to build on from Mek's (2011) study in the context of Panguna. The next paragraph continues the discussion and presents some questions within the context of the current research.

It is important to understand the aspects of alluvial mining against the backdrop of interests by certain international investors wishing to renovate and resume operations abandoned by Bougainville Copper Limited (BCL) following the civil war in the 1990s. Is it economically viable for both indigenous alluvial miners and the ARoB government to promote the sector as an integral revenue source? Are the costs and rewards in favour of the ARoB government, indigenous miners and the populace in the event that an international company resumes operating the mine? Can indigenous alluvial miners and external investors coexist should BCL or another company return to Panguna?

These considerations are viewed through the development theory (Harris 2013) paradigm for deeper illumination. ARoB being a least developed region, even by third world standards, could do well to ascertain factors and aspects that would contribute towards ARoB's overall development. In this paper, the word development implies shift or movement to an improved position. The use of development theory may give deeper understanding on how the change process unfolds as actors rise up to the challenges of a constantly changing world. The contribution of this study to the development theory is now discussed.

Theoretical paradigm

The development theoretical paradigm may reveal the determinants connected with alluvial mining in Panguna and other factors that may shape the change process into the future. Figure 2 (below) shows a bubble diagram delineating the actors involved in the process of change as ARoB anticipates long-term tangible developments. The principal actors in this theoretical framework (TF) are the alluvial miners who may be driven by insecurity, poverty and other demands of the modern world to take up alluvial mining, perhaps seeking wealth or motivated by other aspects. The motivations to engage in alluvial mining for want of revenue may be viewed as increasing wealth at the microeconomic layer which may in turn fuel changes in terms of gross domestic product (GDP). This is possible either through direct or indirect economic streams, direct taxes and respective government regulatory fees.

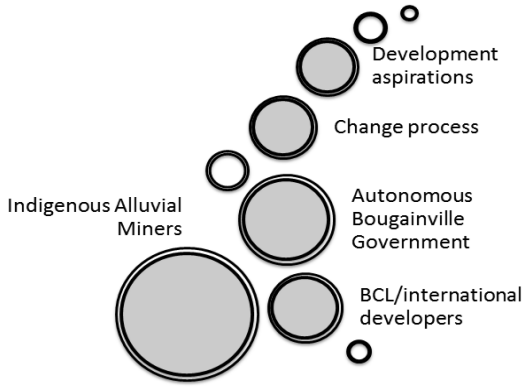

Figure 2: TF showing actors triggering change towards development (Source: Author)

The bubble schema (Figure 2) is used because it clearly displays the local, national and international actors and positions them in the change process. Development theories are about understanding how the processes of change take place (Harris 2013). Alluvial mining by the indigenous population can be viewed from this perspective, in particular taking note that ARoB has gone from a successful mining based province with BCL through a turbulent period and is

now undergoing possible restoration. The regression from mining to turmoil then on towards restoration shows silhouettes of change involving local actors, the state, international players (who are market oriented), supplemented by internal and external institutional diversity.

This research is the first involving alluvial mining in Panguna and its contribution to the theory is unique since the application is contextualised. The actors perform and operate in various capacities towards developmental aspirations into the future. This is consistent with the development theory within which I discuss themes, ideas and values harvested from the survey and the observations accumulated over the tenure of the research. The next section examines the current literature on alluvial mining.

Literature

An examination of the literature reveals that alluvial mining in Papua New Guinea (PNG) dates back to the colonial period in places like Wau/Bulolo, Koiari and Milne Bay among others (Bordia 2000). Nearly all universities, colleges and research entities have been engaged in teaching, research and writing on various aspects and perspectives of alluvial mining or similar subjects in addition to mainstream topics. The University of PNG and PNG University of Technology both organize degree programs covering the full spectrum of mining topics (Bordia 2000). Also, University of Goroka (UoG) has scholars taking up case studies on the subject. For example, Mek (2011) of UoG researched and published a paper titled ‘Artisan small-scale gold mining in Papua New Guinea: Meriyaka Alluvial Gold Mining – A case study’. I now consider some of the findings from Meriyaka and others.

According to Mek (2011), there are more than 2,500 registered alluvial miners operating in both old and new deposits across PNG. A report on small scale mining in PNG (Susapu and Crispin 2002), reveals that Panguna is not

categorised as a major alluvial mining operation, instead the locations that make up the top four are:

- Wau/Bulolo areas in Morobe Province
- Maprik area, East Sepik
- Mt Kare and Porgera areas in Enga Province, and
- Kainantu area in Eastern Highlands Province.

Despite not being in the top four, alluvial mining in ARoB has gradually extended to other areas such as Karato (Central ARoB), Wisai/Buin/Torokina (South ARoB) and Tore in Tinputz (North ARoB). This spread of alluvial operations covers the whole island with the tendency for people to gravitate to the areas known to contain gold nuggets as well as fine gold. Whilst this paper only focuses on alluvial mining in Panguna, the following chart (Figure 3) displays the total mining population in PNG.

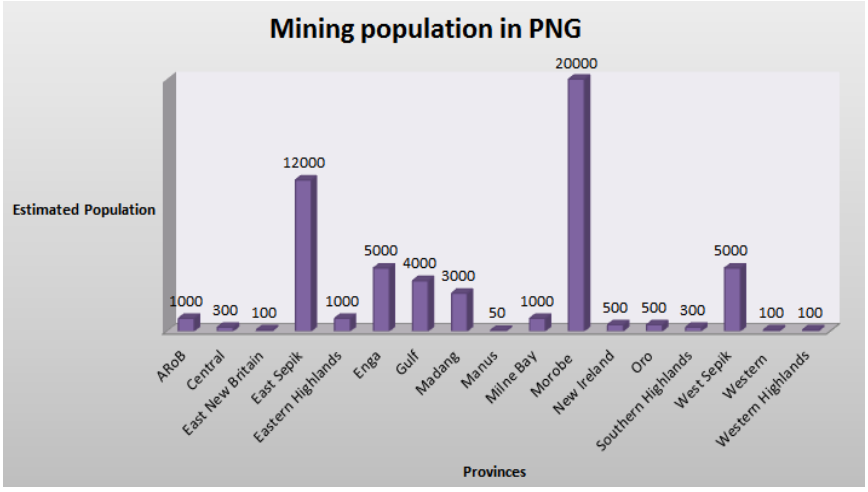

Figure 3: Alluvial miners across PNG with ARoB averagely positioned (Source: Mek 2011)

As can be seen from Figure 3, Panguna (ARoB) is a small player in comparison to other parts of PNG with regard to alluvial mining. So what are the commonalities and differences of Panguna as far as the literature shows? The next section discusses some of these aspects.

Drivers

Since the majority of alluvial miners are from the rural areas, their socioeconomic status plays a role in their participation in this activity. This trend is evident across PNG and equally true for the case of Panguna in ARoB. The prolonged civil war years in ARoB gave rise to a population in the lower rung of the socioeconomic ladder who then commenced alluvial mining to better themselves. It is this situation that is responsible for motivating individuals to become involved in activities that are perceived as generators of income, in this case alluvial mining.

The perceived increase in the price of gold on the international market motivates alluvial miners, although many of these miners may originate from districts producing other commodities such as coffee, cocoa, copra and fresh food produce. However, the preference for alluvial gold mining over these other commodities is also evident. For the case of Panguna, the number of alluvial gold miners (Figure 3), although clearly visible, is lower than those engaged in cocoa, coconut, poultry, piggery, fishing and fresh food produce in all quarters of ARoB. Hence, whilst alluvial mining operates in Panguna, other citizens have other revenue streams or economic activities on which to depend.

There are a number of external actors who obviously value the mineral deposits from various perspectives in Panguna including BCL (legal owner of Panguna mine) and other market oriented actors. These actors possess a number of roles including providing a market for alluvial products and triggering movements in demand which ultimately set off supply activities. This, in turn, maintains the perception of value among alluvial miners who persist with their activities.

What are the alluvial mining practices in Panguna and how do these compare to similar activities in other parts of PNG and the world? This issue is discussed next.

All things being equal, alluvial mining practices in Panguna are not too different from other parts of PNG. However, in nearby areas such as Karato, gold nuggets have been found. In Panguna, alluvial mining techniques range from the use of sluice box, digging and panning with shovels, gravity pressurised water, crowbars, together with panning dish and mercury use. Most alluvial miners gravitate along the ridges and small streams near the now defunct mine pit while others scatter along Kawerong River. The Kawerong served as the waste disposal channel towards the Emperor's Augusta Bay during the BCL operation. The people along the Kawerong use a range of devices such as shovels, hammer, crowbars, panning dishes and sluice boxes. The use of lengths of poly pipe for naturally pressurised water to wash away earth is a common site while the fast running Kawerong is also used to support the operation of the sluice box.

Mercury use is common in Panguna and indeed other alluvial mining operations like Torokina and Wisai/Buin posing health risks and environmental degradation. Risks to humans from direct use but also indirect effects such as through consumption of contaminated food are ever present. Other places such as Wau/Bulolo have received targeted training, education and awareness regarding proper use of mercury because the consequences from its misuse could be detrimental and persistent. Is the lack of such interventions in Panguna a show of neglect by the government?

Figure 4: Abandoned Panguna open-cut mine offers scenic views.

Alluvial mining

Alluvial mining in many parts of PNG attracts attention from various quarters of society and is often perceived as a profitable venture. The Crown Prince Range hosting Panguna, as elsewhere in PNG, has received its share of publicity and at ground zero, alluvial miners from all parts of ARoB stay focused with hopes of major finds. The copper and gold reserves in the Crown Prince Range are well documented by many including Davies (2005). It is recorded that the areas within the 10 kilometre radius of Panguna hosts low grade copper and gold reserves with good economic potential. However, alluvial mining on the Crown Prince Range dates back to 1930 when lode gold was found at Kupei, located in the north-eastern end.

Panguna Mine

The now defunct BCL started commercial mining at Panguna in 1972 when metal prices were high yielding good profits in the early years (Davies 2005). While BCL and the shareholders benefitted from the mine, the PNG government also benefited from tax and shareholder dividends. The mine

operated profitably until a dispute emerged between landowners and BCL, which caused the mine to close in 1989 leaving a remaining resource of 496 million tonnes of copper-gold ore averaging 0.42 per cent copper and 0.55 grams per tonne gold (Davies 2005, Vernon 2005). Together with lower grade ore, the total of mineable ore is 691 million tonnes of 0.40 per cent copper and 0.46 grams per tonne gold (Davies 2005, Vernon 2005).

At its peak, just before the closure of the mine, the production of ore was 143,000 tonnes per day from four ball mills. The ore was concentrated on location using conventional crushing, grinding and floatation, a process which increased copper content from 0.44 per cent to 30.1 per cent, gold from 0.50 grams per tonne to 31.0 grams per tonne, and silver from 1.41 grams per tonne to 91.2 grams per tonne (Davies 2005, Vernon 2005). The concentrate was piped to the eastern port of Loloho where it was filtered and dried for export. Waste rock was dumped alongside the valleys whilst mill tailings were released thoughtlessly into the Kawerong and Jaba Rivers and thence into the Emperor's Augusta Bay. The mill tailings deposed along the Kawerong and Jaba Rivers during the tenure of the Panguna Mine have today been the target of alluvial miners and many can be seen panning tirelessly day in, and day out.

Survey

Survey data were collected from respondents in Panguna and the surrounding communities in ARoB. Respondents freely expressed their lived experiences and perceptions concerning the challenges, opportunities and future prospects of alluvial mining. The identified themes have been expanded by quotes and anecdotes for deeper understanding and meaning.

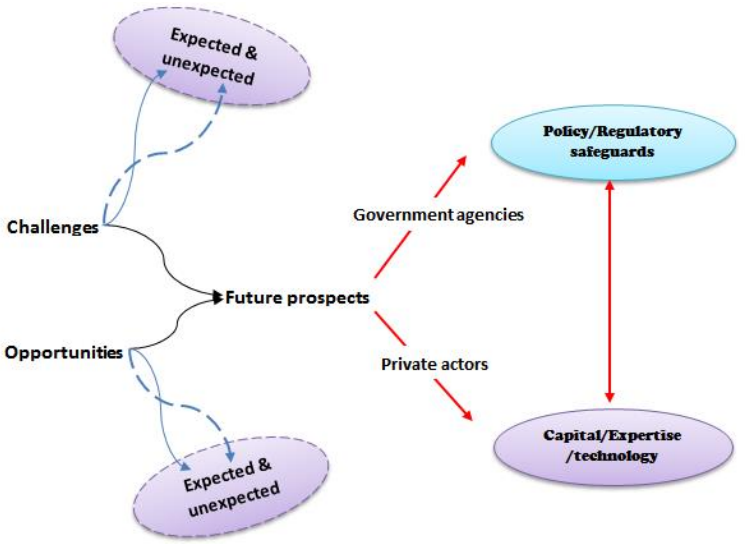

Figure 5: Data analysis template showing category headings for major themes**.**

The survey data were analysed with the help of a template (Figure 5) devised specifically for this research. The next section delineates the main challenges surrounding alluvial mining in and around Panguna.

Challenges

The survey identified challenges experienced by miners and voiced by community members who expressed concern over environmental issues that are related to alluvial mining. Many of these challenges are common but with particular shades. For example, on environment pollution, Tanis (2005) asserted that chemicals from the mine killed all life in the rivers, especially the many species of fish that people once ate. Vernon (2005) affirmed that the environment impacts of BCL's operations were real and considerable, however the mine became a convenient explanation for any aspect of day-to-day existence that people believed had deteriorated over time. The following is a quote from a respondent.

> The sun rays blend with the green vegetation here at Panguna…Here it is cooler though and we get the frequent rains past the midday hour…however, the natural beauty is marinated with challenges…All rivers emanate from these mountains, towards South-West, into the Yaba River and running together towards Empress Augusta Bay…in yesteryears, these were polluted by BCL, but today by mercury from alluvial miners. [FTD 025]

The intrusion of mercury from alluvial mining can have serious and much greater consequences as the ecosystem becomes infected. This may infiltrate the food chain, not only the fish as asserted by Tanis (2005), but also river based vegetables.

The next challenge concerns security, safety and survival. In the context of this research, this refers to socioeconomic parameters such as financial security, safety of well-being and survival in facing the pressures of the economic landscape. Can alluvial mining mitigate the barriers towards financial freedom for a better quality of life for families? Let us consider the following quote.

> Alluvial mining in Panguna is not an economically feasible activity for the average ARoB family…What I mean is that the people who actually do the digging, washing, transporting the earth in those areas do not earn much. They work 'day in, and day out', living under makeshift tinned roofs, inhaling the cold and losing sleep every night…and they struggle…not much to earn…Children born into these families should really be in school, but they also inherit this life as normal so a life of misery and strife persists. [FH 010]

It is a challenge to ensure the security of the family unit in the face of evolving expenses encapsulating all aspects of day-to-day existence. Emerging from a near collapsed society, amidst a growing population, the pressures of the

new economy where basic education and health services are not freely available, security of the family is an issue. This is also regularly heard from street conversations. Some engage in alluvial mining alongside family members including children and this practice breeds a generation of alluvial miners who may require time to understand and accept other activities. A supplementary quote follows next on the same theme.

> The person benefitting the most from alluvial mining in Panguna is the upscale buyer…this person buys gold from the population of miners, at lower than market price…This person hoards the gold from those struggling/poor families digging/dealing with earth in the mountains of Panguna… These families really operate with a hope of a secure income, but they earn below K200 monthly…this is not much money at all. [MXY 021]

The quote suggests that upscale buyers benefit by buying gold from lower tier poor families who are engaged with the actual mining. However, I believe that given right awareness, skills and information alluvial miners along the production chain may benefit appropriately. There are diverse dimensions in alluvial mining which may only be identified and maximised through education awareness and training. Authorities may consider designing appropriate skills and knowledge dissemination programs. The next quote concerns unsafe alluvial mining practices which are believed to have caused deformed births.

> At one point in time, children born to families in the alluvial mining areas were found to be seriously sick with physical discrepancies…they were taken to Buka Hospital where the doctors advised that the physical deformations were due to unsafe alluvial mining and risky practices with mercury. (MBZ 032)

An informant detailed accounts of deformed babies at Moroni villages on the fringes of Panguna, where people have religiously devoted their lives to alluvial mining. It is difficult to justify human costs from unsafe mining practices. Notwithstanding this, few villagers own vehicles allegedly purchased from alluvial mining earnings whilst others own and operate small merchandizing businesses conveniently powered with electricity from rivers based hydro-systems. These and other opportunities are discussed in the next section.

Opportunities

The survey also identified many opportunities associated with alluvial mining in Panguna, similar to those experienced in other parts of PNG and the world. This may be considered a domino effect, where impacts of alluvial mining flows on to nurture other social and economic undertakings. After many physical visits to Panguna and the alluvial mining areas, I believe that the status quo may persist for some time to come. This is because the gravitation to Panguna and along the Kawerong is significant in numbers with people from all parts of ARoB involved. I further believe that alluvial mining has enabled direct and indirect social economic opportunities which people have reason to value. A respondent gave an account as summarised below.

> Alluvial mining operation in Panguna, including the Kawerong, sees a dynamic and committed community engaged in a number of activities. This may be seen as a rural economy operating, entirely shaped by miners and people see value in the activities including supply and consumption of goods and services both directly and indirectly to sustain the operations. There is no shortage of markets, stores both small canteens and a number of sizeable stores selling all manner of merchandise. [SW 045]

It is not difficult to see that there is a visible socioeconomic hub developing at Panguna, consisting of all manner of trading, transportation and delivery of goods into and out of the area. A health centre is nearby whilst Panguna also hosts a primary school for the populace. Against the backdrop of a growing population, the efforts to provide health and school facilities in the mining area need to be stepped up because the evolving socioeconomic community cannot be denied of such vital services. The next section continues the discussion on income generation initiatives growing in tandem with alluvial mining in Panguna.

Income

Alluvial miners are strongly committed to this important source of income for families. This is manifested by their attitudes, characters and actions. It could well be that for these people, alluvial mining provides a comparative advantage to other forms of income source, or it could be that they lack alternative income generators. One respondent remarked:

> The alluvial miners are busy every day…often seen in numbers…going about their business often with other family members…in the mornings off to the digging sites and in the nights walking back to their dwellings…They carry wares, knives, panning dishes, crowbars and torches positioned on their foreheads…The dirt over their body demonstrates commitment in their daily operations. [KJI 033]

The above quote is only part of the alluvial mining chain because there are various players in the business. For example, there are fresh food producers, petrol and diesel suppliers, niche roadside markets, shops and canteens, entertainment outlets, vehicle repair shops and motor vehicle part suppliers among others. This is not to forget the external buyers of gold and suppliers of mining equipment. I believe that alluvial mining in Panguna, whatever scale or

volume it occupies in comparison to other operations in PNG, is economically feasible in its current tenure.

Infrastructure

Generally, the road system crossing from the eastern town of Arawa over the Crown Prince Range to Panguna is sealed with loose gravel segment joining onto the southwest parts of Nagovisi and Siwai. This enables the flow of traffic and the transportation of goods and services between north, central and south ARoB.

An important infrastructure feature in the alluvial mining is small-scale hydroelectricity generation, which was seen as avant-garde in the earlier years of alluvial mining. Small scale hydro-electricity supply is now the modus operandi of producing and using electricity. Indeed many homes and buildings in Panguna are fed with hydro powered electricity. In fact, it has become so popular that communities in Panguna and nearby areas have become well accustomed to using and enjoying hydro electricity supply. At nearby Paruparu, an isolated community along the Crown Prince Range, locally designed and installed hydro systems to power school and health centre facilities. It is such projects that bring an added dimension revealing changes among households or common facilities which people enjoy. The next section discusses the unanticipated effects of alluvial mining in and around Panguna.

Unanticipated issues

As people entered the business of alluvial mining, other activities emerged bringing in both direct and indirect changes either positive or negative. This is a manifestation of the multiplier effect shaped by people as they venture into activities connected with alluvial mining. The hydro-based electrical energy to power up tools, lighting and hand machinery and is an enabler of socioeconomic change. There may be a number of other outcomes in this bundle of change such as using computers in houses, schools,

healthcare facilities, businesses including personal use and others such as providing entertainment ranging from live music to larger playback stereo units. These are not uncommon in and around the Panguna mining areas. The next paragraph discusses an example of indirect and negative influences which has taken root in the alluvial mining area, one relating to the consumption and abuse of homebrew.

Homebrew is a locally brewed high alcohol content liquor made from garden fruits such as bananas, pineapples and water melons. The ripe fruits are harvested and left to reach the early stages of rotting. After a specified period, the juice is collected into a bowl which is then heated to boiling point from which the steam is funnelled through a condensation tube to a waiting container. The purity level of the fruit juice, prior to the heating and condensation process determines alcohol content percentage, but in the village, the grading is crudely labelled A, B and C. Homebrew is part of the entertainment mix at the Panguna alluvial mining area, but a closer inspection reveals that it is also an economic generator. There have been cases of death from regular consumption of homebrew. Water supply in and around the alluvial mining communities is discussed next.

Water supply

In alluvial mining operations fast paced water supply is important for washing of earth, which is an integral part in the panning process. The natural formation of the landscape where the alluvial mining occurs naturally provides good running water from the higher altitudes for the intended purposes. However, for domestic use, poly pipes are mostly installed from the running streams pouring out of the ridges. The piped water is then tapped into common locations for all dwellers to use for cooking, washing and other daily requirements. This water looks natural and fresh and is commonly consumed without purification treatment methods. Aspects of water quality and its implications on

the citizens around the alluvial mining would form an interesting area of research.

Latrines

The visitations and field trips to the alluvial mining areas failed to identify any form of reasonably and safely constructed latrines in most dwellings or settlements in and around the alluvial mining areas. Those living in the heart of the old township of Panguna use abandoned BCL houses with professionally constructed indoor toilets. Obviously, these abandoned BCL houses will deteriorate over time as there are no signs of maintenance. Dwellers and miners on the fringes and in settlements along the Kawerong use the rivers and the bushes as latrines. Such unhygienic practices pose many health challenges which may compromise the quality of life of citizens. A paradigm shift may be necessary through public information and awareness to install safe latrines.

Future possibilities

The survey provided a closer look at challenges, opportunities and future prospects of alluvial mining in Panguna. Some informants asserted that alluvial mining does not have much to offer to the overall economy of ARoB because it currently does not contribute any income (Tax) to the government. This is to say that alluvial miners are earning income and are not being taxed by the government. This claim is true and was confirmed during the field trips. The lack of coordination in terms of safe alluvial methods and other environmental safeguards were also identified during the field trips. This has other long-term implications with unforeseen detriments. The following sections offer some thoughts on future possibilities based on the identified themes during the field trips.

Employment

Alluvial mining in Panguna has provided both direct and indirect employment for ARoB citizens at various community layers. As long as there are enough mineral reserves, this trend seems set to continue. Many people are involved at the lower layer which involves digging, washing and panning for gold. These people then sell their gold to upscale buyers who undertake further processing by burning out impurities using specialized smelting machines. The upscale buyers are either locally based enterprises, such as the GOLD exchange company headquartered in Arawa, whilst some search for better prices beyond ARoB, usually in Port Moresby. The field trips showed that self-employment opportunities exist along the different tiers of the alluvial mining chain, albeit in an informal manner.

Skills transfer

In order to grow the industry, improving skills and knowledge are important. The status quo vis-à-vis skills and knowledge building is that miners mainly learn by doing. The stakes are high considering health, safety and environmental factors, therefore, skills and knowledge interventions need to be organized formally. This can be done through public private partnerships with the involvement of non-government organizations and other competent entities.

Wealth creation

A community driven social economic hub is emerging in Panguna and along the Kawerong where an array of wealth creation opportunities is unfolding. The survey showed that the community stands ready to embrace it, as witnessed by installation of dwellings, fresh good trade markets, shops, transport and even entertainment outlets in the area. Similarly, an array of indirect wealth creation opportunities such as fuel supply is likely to evolve over time. One notable development in Panguna is the design, installation

and operation of small scale hydro systems to power houses, shops, healthcare and school buildings. This may lead to good life, health and education opportunities as discussed next.

Good life, health and education

The average citizen may experience development in terms of having a good life (being able to earn a living), and having good access to health and education facilities. These indicators could be assessed and compared with the PNG national average to ascertain its real worth. It is noted that alluvial mining in Panguna is happening in previously disputed areas, over which a civil war was fought. Thus, the government may be reluctant to support the growth of the alluvial mining in the area. In this light, it is really the entrepreneurial acumen of the people which is the driving force. However, unsafe practices may cause unforeseen detriments to the environment and the peoples' welfare. An interesting research question may be asked: "Are the current alluvial mining practices any safer than the techniques previously employed by BCL which triggered the civil war?"

Discussions

Theoretical paradigms provide convenient frameworks upon which to grow meaning from investigations and also such paradigms equip the researcher to put into perspective the research findings with current knowledge (Suwamaru 2014). Viewed through the development theory, there are four key players or drivers of change towards tangible development in ARoB. These are the land owners, the alluvial miners, the government of ARoB, and the investor which could be BCL or another appropriately licensed entity. Insofar as this research is concerned, the role of ARoB government is to install supportive legislative and policy instruments to promote mining in ARoB. There has been notable movement in this respect (Tongo 2017), however, consultations between landowners, ARoB government and

BCL still requires further work. For the alluvial miners, it is business as usual, and there have been increases in commerce and trade as shown by the increases in the number of machinery, vehicles, people, lighted dwellings and monetary exchanges. Consider the following comment:

> Over the past two years, Justine has been busy buying gold from alluvial miners…He uses a smelting machine bought from America to process the gold…He makes regular trips on Air Niugini to trade with buyers in Port Moresby…There are two other young Nagovis men who have purchased brand new Toyota Land cruisers from Ela Motors with earnings from alluvial mining. One of these young men even bought himself a new wife from Buin in tandem with the purchase of the vehicle. [MKN 0201]

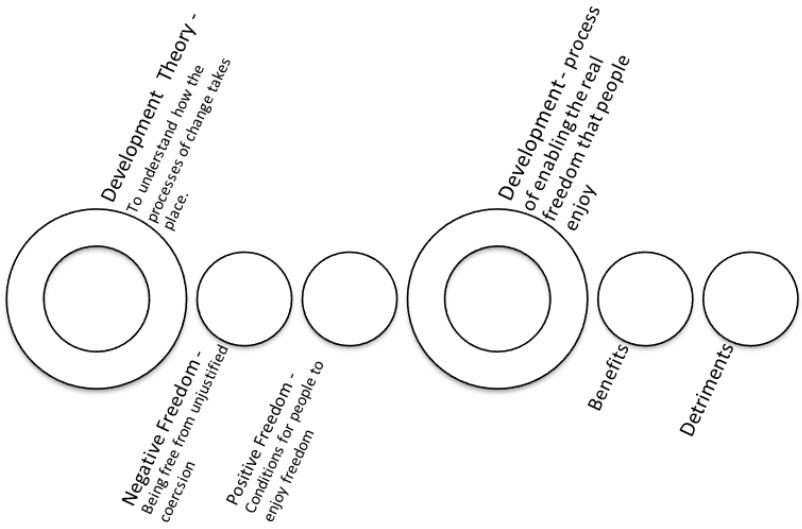

Figure 6: The lens - Development theory paradigm**.**

Development theory has been used in diverse research contexts since the 1940s and continues to advance today as no theory is immune to changes in social values or evolving policy agendas (Harris 2013). In this study, this theory is applied to understand the process of change during the BCL

mining operations and after the cessation of the mine. Whilst it may be perceived as an unorthodox application of the theory, I assert that against the backdrop of the change from pre-mining to mining and post-mining periods, the aspects of the associated events could be understood with the use of the development theory.

The word development in everyday usage is associated with incremental improvements from the status quo. Similarly, the word improvement is connected to change or even progress. Often in popular discourse, development also means improved quality of life or even increase in wealth (Bordia 2000). There is an association between such popular discourse and the drivers of alluvial mining in Panguna because increase in wealth may be one of the many reasons miners indulge in mining, sometimes under hazardous conditions. Then there is the concept of freedom (Figure 6) as discussed in the next paragraph.

Some commentators (Sen, 2000) assert that profit seeking production of goods and services (with economic intent) is only of value if they are enablers of the things people have reason to value. *Ceteris paribus*, this gives rise to freedom that people have to be able to do those things that are valuable for their purposes or the freedom to enjoy a certain way of life (Figure 6). Freedom is often identified as being both negative and positive with clear demarcations. From available literature, negative freedom encapsulates the conditions of bondage from unreasonable coercion, for example, freedom of speech and expression, of association and movement. On the other hand, positive freedom relates to the determinants or conditions which make it possible for people to enjoy their freedom. Are there identifiable conditions among the aspects of alluvial mining in Panguna? From this perspective, the development paradigm highlights the process of enabling the real freedom that people enjoy. In the context of this research, it will be interesting to use this theoretical paradigm to identify indicators (if any) of real freedom, that alluvial miners may be enjoying. Let us now peruse some concluding thoughts regarding the

challenges, opportunities and future prospects of alluvial mining in Panguna.

Conclusion

This research set out to understand the challenges, opportunities and future prospects of alluvial mining in Panguna. The main challenges identified included both expected and unexpected issues which are also both direct and indirect. Direct challenges relate to environmental detriments, skills and technology shortages, where alluvial miners do not possess safe and professional techniques/tools to maximise intended outcomes. Security, safety and survival have also been identified to be challenges facing the alluvial miners in Panguna. Safety and security challenges are ever present to families engaged in mining either from bad mining practices such as use and disposal of toxic matter. Indirect challenges relate to a number of unexpected consequences which have flowered within the alluvial mining perimeters such as homebrew production, sale and consumption.

Opportunities are also being enjoyed through persistence and those willing to invest time and effort may be seen indulging in mining from dawn into the late hours of the night. They earn their money's worth for all practical purposes. However, those who are taking the lion's share in the alluvial mining business are the upscale buyers who buy gold from the population of miners, typically at a lower than market price and make large profits selling to buyers beyond ARoB. There are a number of upscale buyers who are operating in ARoB earning handsome revenues. An interesting future research proposition would be to investigate the mechanics of tax (if any) collected by whatever appropriate authority from alluvial mining in Panguna.

It is difficult to predict the future, but there are economically viable possibilities centred in Panguna and other mining tenements in ARoB. Of course, there are large deposits of

copper and gold which could be mined profitably by authorised entities. The fact that small miners are earning consistent income from alluvial mining with flow-on effects in the areas is evidence enough that economically viable mineral deposits exist in Panguna. There are future opportunities which may be economically developed through partnerships between developers, governments, indigenous miners and motivated citizens. If planned and implemented well, ARoB faces an attractive future prospect to renovate its economy with flow on benefits to the economy encapsulating local businesses, infrastructure, education and health, employment and skills transfer to the ballooning young population. Further research is required to clearly ascertain cost and benefits from mining related operations in ARoB.

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