CIVIL EDUCATION IS THE SOLUTION FOR POVERTY

AND ENVIRONMENTAL MANAGEMENT (CESOPE)

ECONOMICAL AND ECOLOGICAL RESEARCH OF BAHI SWAMP

FINAL REPORT

Prepared and Written by

DR. Damas K. Mbogoro and Mr.Augustino Mwakipesile

The University of Dodoma

Dodoma, Tanzania

And

Edited by

DR. Howard D. Smith

APChem Scientific Consultants

Darwin, Australia

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List of Acronyms

CESOPE – Civil Education is the Solution for Poverty and Environmental Management.

EPA – Environmental Protection Agency

ERA – Energy Resources of Australia

FAO – Food and Organization

FeS_2 – Mineral pyrite

Ha. - Hectare

IFAD – International Fund for Agriculture Development

ISL – In Situ Leaching

ICRP – International Council for Radiation Protection

Kms – kilometers

Kg – kilogram

ppm – parts per million: a measure of uranium quantity in ore body.

U – Uranium

UNSCEAR – United Nations Scientific Committee on the Effects of Atomic Radiation

USAID – United States of America International Development

sq. – Square

TS – Tanzania Shillings

$ - Us dollar

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By Dr Damas K. Mbogoro and Mr.Augustino Mwakipesile

Researchers

Executive Summary

This research was commissioned to determine the economic resources and ecological conditions that support the livelihoods of the people of the area around Bahi Swamp. Its main aim was to compare the market values of existing economic services with what is anticipated from the planned uranium mining. This would help evaluate the actual costs of the intended mining activities, particularly from an environmental sustainability standpoint.

The Bahi swamp area is made up of the whole of Bahi district and five wards of Manyoni covering an area of 6798.4Kms. It has an estimated population of 268,000 persons, mostly farmers who keep livestock of different types. Other economic activities that support contribute livelihoods in the area include fishing in the many swamps and rivers particularly during the rainy season, salt production, harvesting forest products, bee keeping, and, to a lesser extent, commercial activities like owning shops and trading in farm products, livestock, fish and salt.

Based on conservative estimates at farm gate prices, the economic value derived from the major economic activities is TS 278,909,197,400/=. The contributions by major economic activities is as follows: agriculture, TS 113,932,320,000/=; livestock keeping, TS79,913,675,000/=; fishing, TS3,760,350,000/=; salt production, TS 294,000,000/=; forest products, TS 80,511,897,600/=; and honey and wax, TS 496,954,000/=.

Introducing uranium mining in the area would threaten most of these economic activities – save, perhaps, livestock keeping which can be shifted elsewhere. According to geological survey reports (which ones?) uranium is almost everywhere in the swamp area. If the government gives the go ahead to the proposed uranium mining, many people would have to be relocated.

In addition, uranium mining may make the whole area dangerous due to the release of radionuclides and radioactive dust and gases such as radon. If radionuclides are released, they may spread throughout the groundwater and surface water systems, placing the entire swamp area and surrounding districts at great risk. The principal risk will be related to human health particularly if radiation spreads to agricultural and livestock systems and via the food chain into the human population.

Furthermore, uranium mining would greatly affect the biodiversity of the area; it poses a serious threat to the life of birds, particularly water birds (flamingos), fish, vegetation and animals. There would also be negative impacts on the genetic resources which underlie the diversity of crops and livestock on which the people of Bahi Swamp area depend. In economic terms biodiversity is important because about 40

percent of the global economy is based on the biological products and processes. Pollutants from uranium mining can kill organisms outright and can change biochemical conditions and processes occurring within a system and result in systemic changes that degrade habitats and make ecological processes dysfunctional.

On the other hand, the benefits that the country and the Bahi Swamp area community will get from uranium mining include employment opportunities and a royalty fee of 5 percent of revenue paid to the government and from corporate responsibilities. Without taking into account whatever compensation will be paid, financial benefits to the country over the thirteen year period discounted at 10 percent rate of interest will be TS 93,125,012,319/=. This is a small benefit compared with the loss of TS 278,909,197,400/= that represents the estimated current value of the Bahi swamp area. In comparison, the companies will receive an estimated discounted revenue of TS 1,196,750,700,000/=.

CHAPTER ONE: BACKGROUND TO THE RESEARCH

1.1 Introduction

With full Government support, a number of international companies are about to launch uranium mining projects in Tanzania. These projects threaten resources and peoples' livelihoods in the designated areas. The threats include the release of radioactive and toxic material that would contaminate water and land, thus competing with local inhabitant's interests.

In particular the Bahi Swamp would be most affected by uranium mining in an area known as Bahi North, where the Australian uranium mining company Uranex NL intends to operate. Mantra Resources Ltd., Atomic Resources Ltd. and International Gold Limited are also interested in mining uranium in the Bahi district. One of the local peoples' main concern is the possible detrimental effect that mining and long-term disposal of tailings might have on the existing economic values ascribed to the land. This report examines the current socio-economic and ecological values of the Bahi Swamp wetlands and balances this against the value offered to Tanzania's economy through the mining and processing of uranium from this area.

1.2 Background

Situated about 56km west of Tanzania´s capital city of Dodoma, the Bahi wetland is threatened by plans for uranium mining being pushed forward by the Tanzanian government and foreign investors. The swamp is described topographically as a closed depression, where geological faults divert and supply underground water flows of the Bahi drainage basin into the swamp. (Lyamunda and Kurtz, 2009). There are 8 major and 10 smaller perennial streams feeding this unique natural resource. In good rainy seasons, an open water surface with a diameter of around 30km (covering 125,000 ha) can develop and prevail for up to five years (Kamukala and Crafter, 1993).

The Bahi wetlands are a peculiar ecosystem, known for their birdlife and fish resources, both of enormous value for food security and income generation for those living in the semi-arid landscape of central Tanzania and beyond. Various economic activities adapted to the swamp are highly important to people's livelihoods. These include farming, livestock keeping, traditional salt making, fishing and forest products harvesting.

1.2.1 Paddy farming

Erratic rainfall patterns in Central Tanzania often cause failure of rain-fed agriculture leading to famine. Irrigated paddy production in the swamp area is therefore a promising alternative. According to CESOPE, FAO and USAID started introducing advanced technologies for rainwater harvesting and rice production in the Bahi Swamp in 1982. The initial project area of 150ha was extended by farmers to more than 500ha. In 1990 IFAD supported the extension by another 150ha. Currently, the whole area under paddy production can be estimated at around 9,000ha, but an exact assessment is missing. Farmers claim to harvest up to 40 bags per acre, making Bahi rice production an important contributor to food security in the region and beyond.

1.2.2 Fishing

Fishing is one of the major economic activities in the wetlands. The Wetlands of Bahi are famous for the production of Clarias and Tilapia (Bakobi, 1993) which is a major source of nutrients and income to local people. One of the ways of preserving/processing fish is by smoking. This not only underlies the need to examine the link between fishing-related activities and the utilization of other natural resources in the wetland areas, but also the need to understand how the changes that are occurring in the wetland area affect the fishing communities.

1.2.3 Grazing ground

As is the case in most African semi-arid areas, many people around Bahi rear livestock –keeping them as traditional herdsmen. The swamp offers important grazing areas for them.

1.2.4 Traditional Salt Production:

In several villages located along the edge of the Bahi Swamp, people are opportunistically generating income by using traditional technologies to produce salt, which is exported to the neighboring countries like Burundi and Rwanda.

1.3 Statement and Significance of the Research Problem

1.3.1 Statement of the Problem

There is a serious risk that uranium mining would threaten the whole system of Bahi Swamp by emissions of poisonous and radioactive gases, release of contaminated dust, destruction of land and consumption of enormous amounts of water during mining and processing. The most serious source of hazards however could be seen if huge tailings dumps were constructed. These dumps would hold the slurried waste materials created after processing of the ore to yellow cake. This slurry often contains high concentrations of radioactive uranium and thorium and can release the poisonous radon gas.

1.3.2 Significance of the Research Problem

Some scientific studies, mainly conducted by University of Dar es Salaam's Institute of Resource Assessment and Sokoine University of Agriculture, have assessed the economic potentials of Bahi Swamp. One study estimates that irrigated paddy comprises 65% of the total household grain production and contributes 59% of household income while fish maintains 10% of household food and 36% of household income (Munishi, 2008) .Other examples of the use and sustainability of the swamp resources on the livelihoods of nearby villages have also been published (Mwakaje et al, 2009)

However, the proposed uranium mining brings the need to assess its likely impacts on general contribution of Bahi Swamp to food security and economy in the region and beyond. This report provides a detailed study of the extent to which this natural resource system would be affected by uranium mining. It specifically targets groups of peasants, livestock keepers, traditional fishermen, paddy farmers, traditional salt producers and participants in other economic activities in and around the Bahi Swamp. The outcomes are intended to inform the policy makers and other stakeholders on the importance of current economic activities to the people of Bahi and the implications of uranium mining in the area.

Uranium mining is new to Tanzania. It is therefore important for the public to be aware of the special risks it engenders and how the areas to be mined will be affected. This would enable the general public to ask critical questions, and weigh the benefits to the local economy against its potential to destroy it by depleting the wealth of their land. It would also provide them with a clearer picture of whether the gains from uranium mining are more or less likely to offset what might be lost through land acquisition or long-term contamination of the environment.

CHAPTER TWO: BACKGROUND INFORMATION ON RADIATION, URANIUM MINING AND THE ENVIRONMENT IN BAHI AREA

2.1 Radiation

There are three principal natural sources of radiation – cosmic rays, minerals and the human body. It is estimated that about 50% of natural radiation received by man comes from cosmic rays, the strength of which increases with altitude (UNSCEAR, 1991). The second most abundant is terrestrial radiation emanating from radioactive materials in rocks – mainly from the two longest lived natural nuclides – uranium and thorium. The level of exposure to an individual from this source depends on the geology of each area where they live. Radiation from the human body depends on our genetic make-up but is influenced by external sources such as cosmic rays, heat and contact with radioactive species such as uranium.

There are three principal routes by which external radiation can enter the body: ingestion, inhalation and direct contact with the skin. It is estimated that about two thirds of the effective radiation dose that people receive from natural sources comes from radioactive substances in the air they breathe, the food they eat and the water they drink (UNSCEAR, 1991). Almost all the dose under this category comes from terrestrial sources, largely from the decay of Uranium and to a lesser extent from the decay of thorium. Radioactive substances like this often follow common but complex pathways through the environment before reaching man. A diagram describing some of the basic conceptual pathways relevant to the potential transport of radioactive nuclides from mining activities in the Bahi Swamp region is shown in Section 2.2, Figure 1.

2.1.1 Radiation from terrestrial sources – uranium

Uranium is a metallic chemical element usually recovered from uranitite, pitchblende or carnotite ores through an acid or carbonate leaching process. About half of the word's uranium comes from open-cast or cut mines; the rest is from underground mines. The ore is then taken to mills, usually located nearby, for processing. Both the mines and mills emit radioactive discharges to the environment In the short term, mines account for nearly half of the dose from the two operations. Mills are responsible for much greater long term problems as they produce large amounts of waste or "tailings" – estimated at more than 500 million tons in North American active mill sites, for example.

These wastes remain radioactive millions of years after the mills cease operation, providing potentially the greatest long term contribution to human exposure, even though it may only represent a fraction of normal background levels. However, improved management of tailings can reduce this amount of additional radioactive exposure further. As tailings tend to be kept in open, uncontained piles or covered with water behind dams and dikes, providing better protection can cut radioactive emissions by up to a million fold. Open pile tailings can, for example, be covered with asphalt or polyvinylchloride, though such covers must be well maintained long into the future. Currently, the best practice being undertaken is to line the pit void with impervious materials, return the tailings to the pit void and bury them under several metres of rock and soil.

After milling, uranium is turned into fuel by further processing and purification, usually by passing it through an enrichment plant. These processes give rise to both airborne and liquid discharges. But the doses are very much smaller than those from the other parts of the fuel cycle – mining and milling.

2.1.1.1 Radium and radon

Radium is found in all uranium-bearing ores. Radium is over one million times more radioactive than the same mass of uranium and its decay leads to production of radon. Radium is of environmental concern because it is chemically similar to calcium and therefore has the potential to cause great harm by replacing it in the bones if it accumulates in animals and people. Inhalation, injection, ingestion or body exposure to radium can cause cancer.

Radon is produced during decay of radium and uranium. It is one of the more important sources of natural radiation and is described as being a tasteless, odorless, invisible, gas about eight times heavier than air. Radon is a problem because it is released in bulk quantities during mining and processing of uranium and, being denser than air, is readily contained by pit voids and buildings. Radon gas from natural sources can accumulate in buildings, especially in confined areas such as attics, and basements – especially in temperate climates. Sources of radon in buildings include underlying soil, building materials, outdoor air, natural gas and water. Epidemiological evidence shows a clear link between breathing high concentrations of radon and incidence of lung cancer.

2.1.2 Radiation from man-made sources

2.1.2.1 Introduction

Over time, man has learned to artificially produce several hundred radionuclides and has learned to use the power of the atom for a wide variety of purposes: from medicine to weapons; from the production of energy to the detection of fires; and from illuminating watches to prospecting for minerals. In most cases, man-made sources of radiation can be controlled except when it is due to fall out from past nuclear explosions. The key man-made sources of radiation are medical sources, nuclear explosions, and nuclear power.

2.1.2.2 Medical Sources

Medicine is one of the greatest sources of human exposure from man-made radiation. Radiation is used both in diagnosing and treating of diseases, and is one of the main ways of fighting cancer. In principle, the application of radiation to medicine can be beneficial. However, sometimes people receive unnecessarily high doses

2.1.2.3 Nuclear explosions

The second half of the twentieth century exposed the world to radiation from fall-out from nuclear weapons. Almost all of this was the result of atmospheric explosions carried out to test nuclear weapons. But this practice was stopped after 1980; only underground tests, which generally produce no fall out, are still being carried out. The fall-out from radioactive debris did not lead to much human exposure most of the radionuclides were produced in very small quantities, diluted in the atmosphere or decayed quickly. However, doses from most radionuclides produced will be delivered over long periods of time as most have decay rates up to thousands of years. ^{14}C is a good example. Of course the effects of the fall-outs were different depending on where the testing took place. The Northern Hemisphere, where most of the testing was done, received most of the fall-out

2.1.2.4 Nuclear Power

Production of nuclear power is the next most controversial of all the man-made sources of radiation after nuclear weapons - although, in practice, it makes a very small contribution to human exposure. Under normal circumstances, most discharges from nuclear power facilities emit very little radiation to the environment. The main concerns come from the need to mine uranium for fuel and the potential for disaster which may lead to leakage of nuclear radiation.

The nuclear fuel cycle starts with mining nuclear fuel. Following power generation, the irradiated fuel is sometimes reprocessed to recover uranium and plutonium. At each stage in the cycle. Radioactive materials are released at each stage in the cycle. Although typically low, doses released vary in space and time. Generally speaking, the further people live from a particular nuclear installation the less radiation they will receive from it. Eventually the cycle ends with the disposal of the nuclear wastes. The transportation or disposal of these, particularly in densely populated areas, can become a serious risk to public health.

2.1.3 Effects of radiation on people

Radiation is harmful to people because:

- it can trigger only partially understood chains of events which lead to cancer or genetic damage;
- it can kill cells and these may not be replaced quickly;
- cancer and genetic damage can be caused at any level of dose, with damage done by high doses normally becoming evident within hours or days;
- radiation induced cancers can take many years and usually decades to emerge; and
- it can cause genetic damage, with associated hereditary malformations and diseases taking generations to show in the children, grand children or remoter descendants.

2.2 Uranium Mining and the Environment in the Bahi Swamp Area

2.2.1 Introduction

There is a great deal of literature on the impacts of uranium mining on the natural environment, its placement or disposal, and management of mill tailings.(Heinrich Boll Foundation, 2006 and Merkel and Hasche-Berger eds, 2006). But this literature is generally limited to qualitative descriptions of the impacts in terms of contaminated soil, surface waters, ground waters and lake sediments, among others. Quantitative analyses tend to be confined to the areas and volumes affected concentrations of radioactive elements, or activity levels and doses of radiation. Literature describing the contamination of environmental media directly linked to consumption and potential uptake of radionuclides by humans, principally through soils, air and water, also exists (UNSCEAR, 1991)

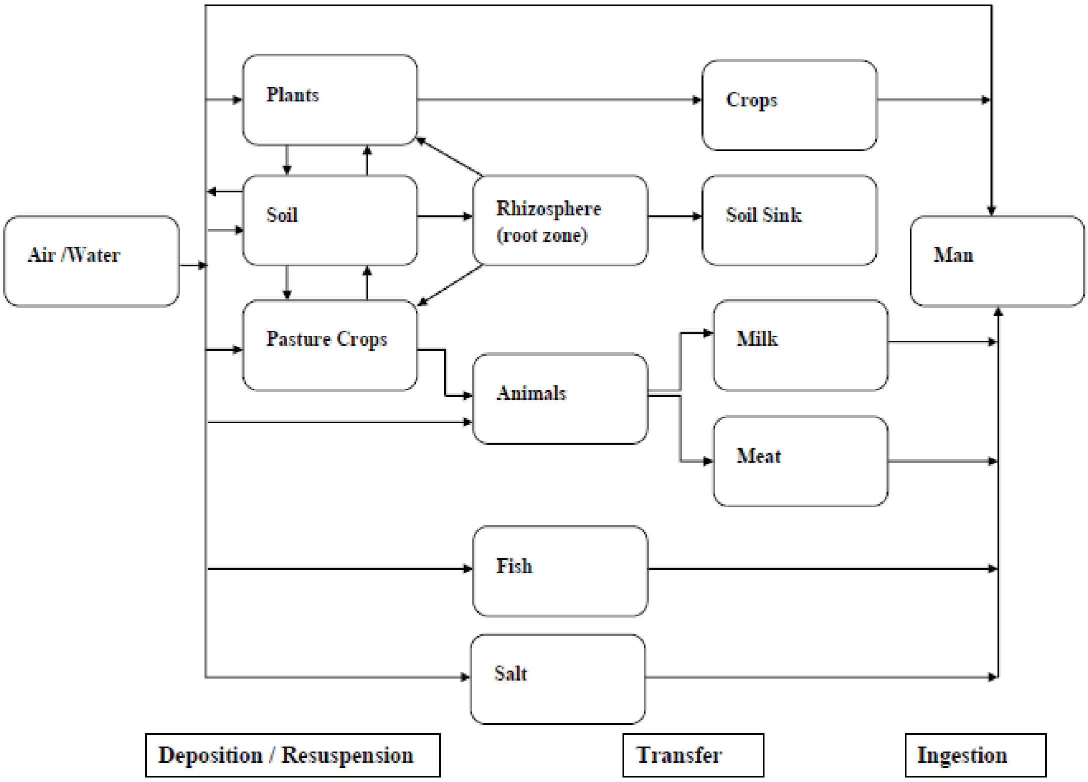
Research into the biological impacts of the complete nuclear fuel cycle is a relatively new science and is strongly biased towards the risks, hazards and impacts to humans from the fuel fabrication, power generation and fuel reprocessing or disposal parts of the cycle. Interest in the biological impacts from uranium mining and milling has also grown due to the realization that:

a. Fisheries in the vicinity of some uranium mines were deteriorating;
b. Radionuclides could be taken up and concentrated by plants, thereby posing a potential risk to vegetation as well as to animals higher in the food chain, including humans;
c. Radionuclides could be taken up and concentrated by animals, thereby posing a potential risk to the health of individuals, communities and ecosystems as well as animals higher in the food chain, including humans;
d. Radionuclides may concentrate in bottom sediments becoming available to bottom feeders and cycling multiple times through the aquatic food chain over the long term;
e. Radiological doses can be transferred to man through the food chain;
f. Rangible impacts on human health from radioactive contamination associated with uranium mines and tailings piles may also be having significant impacts on the environment; and
g. The ICRP's assumption that if human beings were adequately protected other species would also be protected may be in error.

Since the late 1970s there has been a general increase in concern for the environment, presumably due to evidence that the actions of humans are causing visible and significant environmental changes. Furthermore, close attention is now being paid to the larger implications of harm being caused to elements of particular ecosystems with consequent impacts on biodiversity. It is perhaps for these reasons that the issue of environmental protection in the context of ionizing radiation is being addressed in many countries.

The potential effects of radiation and the ease by which radon can be transported by water makes it important that a full understanding of the environmental pathways through which radon transfer to man is achieved. The first step in this process is to develop a conceptual picture of how the environment might be impacted and use this to drive further studies. A basic conceptual picture of transfer via the atmosphere and waterways for Bahi Swamp is provided in Figure 1 (below).

Figure 1: Conceptual Environmental Pathways for Transfer of Radionuclides for the Bahi Swamp



2.2.2. Uranium and Water

Uranium mining often releases large volumes of groundwater into nearby rivers and lakes. This water often contains high levels of uranium and other dissolved chemical species that can be detrimental to the wider environment. Radioactive dust and radon gas, which have the potential to increase the risk of lung cancer among residents living nearby, is released during mining, while waste rock is dumped in large piles on the ground. Even the most benign of these may contain elevated concentrations of radionuclides when compared to other surface rocks. Other waste piles consist of ore with too low a grade for processing. These pose a threat to the environment values as they continue to release radon gas or seep water containing radioactive and toxic materials for long periods of time.

Under heap leaching for example, the alkaline or acidic leaching liquid – often sulfuric acid –is introduced on top of the pile and percolates down until it reaches a liner below the pile, where it is caught and pumped to a processing plant. Such piles present a hazard during leaching because of their potential to release dust, radon gas, and leaching liquid. After completion of the leaching process, a long-term problem may result from naturally induced leaching if the ore contains the mineral pyrite, as in the case of uranium deposits in Thuringia, Germany and Ontario, Canada. The presence of water and air may cause a continuous, bacterially-induced production of sulfuric acid inside the pile, resulting in the continued leaching of uranium and other contaminants for centuries – even permanent contamination of groundwater resources (Heinrich Böll Foundation 2006).

The population in the Bahi Swamp area relies upon its natural resources to generate an income and would be impacted adversely by uranium mining. A good example is the established small-scale rice irrigation schemes which divert water from the inflowing rivers. A combination of water extraction for uranium mining and an increase in irrigation development, would pose a significant threat to the ecological integrity of the wetland as well as the livelihoods of many of the people who depend on it. In addition, the remaining water supplies required for other local uses could be contaminated by mining, leading to increased risk to the health and well-being of the local inhabitants.

Plate 1: Bahi Wetlands

Plate 2: Water source within Bahi Swamp

2.2.3 Uranium and Biodiversity

Rural people in developing countries largely depend on their natural resources for subsistence. Biodiversity represents the core of that subsistence; it is central to a whole range of ecosystem services, storing carbon and recycling freshwater, that benefit all living organisms. Indeed, biodiversity is shorthand for the range of genetic resources which underlie the diversity of crops and livestock on which we all depend.

Conserving species and genes can yield enormous benefits for present and future generations. Although it is difficult to ascribe tangible value to biodiversity, there are clear ethical and aesthetic values which exist in a feedback relationship with economics. The more we admire diversity and appreciate it, the more protected areas and ecotourism can realize direct benefits.

Uranium mining is controversial from an environmental and biodiversity protection perspective because of the perception of potential accidents that could occur at any stage of the nuclear fuel cycle, including the storage and disposal of various levels of radioactive wastes. The release of radionuclides into the environment can kill organisms outright, change the biogeochemical conditions and processes occurring within a system and result in systemic changes that degrade habitats and make ecological processes dysfunctional. Biodiversity associated with sites used intensely by humans may be most at risk, although non-point based effects of pollution on biodiversity such as downstream water pollution and downwind air pollution can also be significant.

Most uranium mining and disposal of wastes occurs in remote areas considered wilderness, prompting the view that since only few people are impacted, the impacts are either insignificant or irrelevant. However, during the milling of uranium ore, radioactive substances are left in the tailings and about 70%, of the substances take tens of thousands of years to decrease to a safe level. Thus improved methods of dealing with stockpiles and mining wastes are essential to prevent release of contaminants and ensure proper protection of the environment even in the most remote of areas.

2.2.4 Uranium in the Bahi Swamp Region

2.2.4.1 Introduction

The Bahi Swamp catchment area is a dry lake covering over 1,000 square kilometers and incorporates an extensive closed drainage system that has developed over 27,000 sq km of weathered uranium rich "hot" Archaean granites. The Lake Bahi system is the final repository of all the uranium rich fluids draining from these granites and has been recognized as an important uranium province since the 1950's when the Geological Survey of Tanzania reported uranium near the centre of Lake Bahi. But they generated little interest until the spot price of the mineral increased rapidly to exceed US$100 per pound in the later part of 2000. In the face of this increase in value, mining possibilities are currently being evaluated more closely by a number of companies and the Tanzanian Government – all of whom keen to profit from the mineral resources.

The surrounding Bahi intracratonic basin is defined as an extensive closed internal drainage system that feeds into the Bahi Swamp – itself considered to be a large playa lake. The uranium targets are described as calcrete-hosted uranium mineralisation near to the surface and sandstone-hosted deposits within buried fluvial channel systems.

The amount of information regarding exploration activities in the Bahi Swamp area is limited. However, several companies are now seeking uranium in this part of Tanzania. During this study, local leaders and individuals indicated that there had been uranium prospecting activities at Chikuyu in Manyoni district, and Magaga, Chali , Ilindi and Naguro in Bahi district, which indicates that the whole swamp area is likely to be affected by uranium prospecting and mining. Indeed, several multinational companies have commenced or are about to commence exploration for uranium in this part of Tanzania. A brief outline of each company's exploration activities and outcomes is provided below. However, no uranium mining has occurred in the Bahi region to-date

2.2.4.1.1 Mantra Resources Bahi North Project.

Mantra has two main areas targeted for exploration in Tanzania – Bahi Swamp and Mkuju. The exploration targets at the Bahi North Project are located about 70 km northwest of Dodoma and cover an area totaling about 1,640 square kilometers. The principal prospecting sites are at Makanda and Kisalalo, which are part of the Manyoni District where deposits similar to Mkuju are found. If uranium processing at Mkuju proceeds as expected, Mantra will be in a sound financial position to pursue mining and processing at Bahi and other areas within Tanzania. Mantra Resources has identified a number of anomalies, but has yet to confirm the discovery of any mineable resources.

2.2.4.1.2 URANEX Bahi Project Area.

Uranex's Bahi project is located approximately 70km to the west of Dodoma and contains an inferred resource containing between 7 and 15 million pounds of U_3O_8, (uranium oxide) associated with other deposits of mineralization within close proximity of the nearby playa lake system. The main deposit at Manyoni is shallow, extending to a depth of around 13m and covering an area of about 20 square kilometers. Being close to the surface, Uranex anticipates that mining will be low cost and will commence in mid 2013. Uranex is confident that significant scope exists for the location and definition of further resources within neighbouring Playa Lakes, including the vast Bahi Lake. It plans to construct a single plant capable of processing ores from its multiple resources.

2.2.4.1.3 Atomic Resources Limited Bahi Project

Atomic Resources has been granted three concessions at Bahi, Bahi North and Handa – all located about 180 kilometres northwest of Dodoma. During a visit to the Chipanga division in the south of Bahi district, we were also informed that Atomic Resources Limited was prospecting for uranium at Magaga. Although the company has begun exploration activities, it has yet to report any significant outcomes.

2.2.4.1.4.International Gold Limited/Central Iron Ore Joint Venture

At Bahi / Manyoni, the Joint Venture holds in excess of 2,500 square kilometres of tenements, two of which adjoin the western boundary and another that adjoins the southern boundary of the tenement that holds the Uranex Manyoni JORC compliant uranium resources. Some major uranium mineralized anomalies in the Bahi Manyoni region, including one that is approximately ten kilometers in length by two kilometers in width, have been identified. But no detailed drilling or resource estimation has been undertaken.

2.2.4.2 Major Issues likely to be associated with uranium mining in the Bahi Swamp area.

There has yet to be any uranium mining in the Bahi Swamp area, so it is difficult to predict what will actually happen. However, since at least one company has indicated its intention to mine, it is important to anticipate the likely outcomes of such mining activities. These would depend on the types of mining and processing undertaken. A brief description of the possible mining types is provided below.

2.2.4.2.1 Types of uranium mines

There are three types of uranium mines which might be employed in Bahi: open cut mining; underground mining, and in-situ leach (ISL) mining. Open cut mining is applies where ore bodies lie close to the surface – to a maximum depth of about 250m. It involves digging a large pit and the removing much overburden and waste rock, which creates a substantial change in the environment. Strip mining is similar to open-cut, but works best where the ore bodies are on the surface and penetrate to a depth of not more than about 20m. It is advantageous because rehabilitation of the environment can be undertaken progressively as the mining goes on. The shallowness of the Bahi deposits suggests that strip mining is likely to be the method of choice for Uranex.

Ore bodies located at depths greater than about 250m are uneconomical to mine by open cut methods. Underground mining is usually employed in such cases. Underground mining involves construction of access tunnels and shafts, resulting in the removal of only small amounts of overburden or waste rock. The smaller volume of waste created means that this type of uranium mining does not normally result in significant environmental impacts.

As for ISL, it is employed where ore bodies lie in ground water in porous unconsolidated material. The uranium is removed by acidifying the ground water and pumping it out for processing (an alternative means of using carbonate solutions is required for some ore types). This type of uranium mining means that the recovery of uranium minerals can be achieved without any ground disturbance, however if the groundwater is not present in a confined system widespread contamination of groundwater systems could occur.

2.2.4.2.2 Mining and processing

After the ore bodies have been mined by open cut or underground methods, they are put through a mill where they are first crushed to break up the largest pieces into smaller ones. These are then crushed further to reduce the material to smaller pieces of 20mm or less. The fine pieces are then ground in water to produce slurry of fine suspended particles. This slurry is then leached with sulfuric acid to dissolve and remove the uranium oxides. Most of the ore does not get dissolved in the leaching process and these solids or "tailings" are then separated from the uranium rich solution by allowing them to settle. The liquid containing uranium is then filtered and the uranium separated by ion exchange methods or counter-current washing.

Solid waste products from the milling operation are pumped as slurry to a tailings dam. These wastes comprise most of the original ore and retain most of its radionuclides. In particular they contain radium and thorium that are present in the original ore. When radium undergoes natural radioactive decay one of the products is radon gas. Radon gas and other decay products are radioactive and, because the tailings are now on the surface, measures must be taken to minimize the emission of radon gas and the potential loss of other radionuclides. During the operational life of a mine, this is normally achieved by covering the tailings with water to reduce surface radioactivity and radon gas emission.

At the end of the operational life of a mine, the tailings dam is normally covered with at least 2 meters of clay and topsoil to reduce radiation levels to near those normally experienced in the place of the mine, and to facilitate vegetation cover to be established. However, these facilities are prone to erosion over long periods of time. So best practice requires tailings to be returned underground, emplaced in mined out pits or placed into specially engineered dams.

Management of water is also important because run-off from mine stockpiles or waste liquors from the milling operation can be readily transported into groundwater or surface water systems. During mining, contaminated water is collected in secure retention ponds for isolation and recovery of any heavy metals or other contaminants. The liquid portion is disposed off either by natural evaporation or recirculation to the milling operation. However, best practice requires companies to adopt a zero discharge for pollutants. So, high technology water treatment plants are usually constructed to treat the water prior to its disposal.

2.2.4.3 The Risks to Bahi Swamp Area.

First, mining in the Bahi region has the potential to create widespread and long-term damage to the economic and ecological values of the Bahi Swamp environment. The principal risk rests with the management of water – especially the possibility of radionuclide contamination, which may be passed through the food chain, thus creating a long-term risk to public health. In addition, acidification of water may have direct impacts on local fisheries or indirect ones on the livestock industry if pasture is affected. Futhermore, the resumption of land for mining purposes may impact negatively upon both the stocking and agricultural capacity of the region.

Second, the long term management of uranium mill tailings presents a major environmental challenge. Since these mill tailings contain most of the original radioactivity of the primary ore bodies, they must be isolated from the wider environment for many thousands of years if their impacts are to be successfully negated. Returning the materials to dug-out pits is the best means achieving this. The company, Energy Resource of Australia (ERA), for example, is obliged through the licensing agreement to isolate its tailings for over 10,000 years. Given the difficulties and costs involved in long-term tailings management, the commitments of the foreign companies to stay in Tanzania to ensure proper mitigation of these impacts occurs must surely be questioned.

Third, Australian companies come to Sub-Sahara for many reasons. First, the demand for uranium has gone up and therefore the prices have become attractive to enable uranium mining in marginal deposit areas to become profitable. Second, to escape the more stringent regulations that govern the mining of uranium in developed countries like Australia and Canada. This was aptly captured in 2006 by the Executive Director of Paladin Energy of Australia, which has operations in Malawi and Namibia, when he said that "The Australians and the Canadians have become over-sophisticated in their environmental and social concerns over uranium mining – the future is in Africa" (Australian Conservation Foundation, 2010). Many sections of the Tanzanian society fear that such companies have come simply to avoid tough regulations that govern uranium mining in their countries; for countries like Tanzania have no proven systems of protecting the environment from the risk of contamination by radionuclides. Designing and supervising implementation of regulations that can protect the environment and limit the potential damage to human life by radiation and poisonous gases and chemicals is a major issue. Developing countries like Tanzania have limited experience and expertise in designing and supervising implementation of regulations that will make uranium mining in the country less harmful to human life and the environment.

Finally, uranium mining occurs in remote areas that are considered to be of limited value as they are considered to be wilderness. In the case of the Bahi Swamp, uranium mining will take place in an area that is fairly populated, with a density of 40 persons per square kilometer. Should people need to be moved from the Bahi region to allow mining to proceed, it will cost the government a lot of money to build economic infrastructure like school buildings in the new places. Moreover, the Bahi swamp area being less than 50 kilometers away is close to the major population centre of Dodoma and should not be considered a remote area where surface tailings can be left to erode and decay slowly over many decades. Should this occur, uranium mining may be detrimental rather than beneficial to the local region and Tanzania as a whole.

CHAPTER THREE: ECONOMIC AND ECOLOGICAL CONDITIONS OF BAHI SWAMP AREA

3.1 Economic Conditions

3.1.1 Area and population

The Bahi Swamp lies within the rift valley system. It comprises Bahi districtand the five wards of Manyoni district (i.e. Majiri, Maweni, Kintinku, Chikuyu and Makanda). The district covers 5444,842 hectares or 5,448.4 sq.kms while the five wards occupy an area of 135,000 hectares or 1,350 sq.kms. The current population of Bahi district is estimated at 203,216 persons and that of the five wards of Manyoni district have an estimated population of 64,936. Thus the area has an estimated population of 268,152 persons who live in 56,110 households. About half of this population can be categorized as dependent (that is, very young and the old) and the remaining is the working population.

3.1.2 Main Economic Activities of the Area.

3.1.2.1 Agriculture

Agriculture is the main economic activity of the people living in the Bahi Swamp area. About 80 percent of the population of the area is engaged in the agriculture sector. About 378,207 hectares (70 percent) out of the total area is suitable for agricultural activities. However, until 2006, only 174,226 hectares (or only 44 percent of the total arable land) was actually producing crops out of which about 2,000 hectares were irrigated. More land has since come under crop production. The major food and cash crops grown in the area are millet, sorghum, maize, paddy/rice, cassava, potatoes, legumes, peanuts, groundnuts, sunflower, simsim, grapes and pigeon peas. Major food crops include maize, cassava, potatoes, legumes, pigeon peas, millet and sorghum. Crops that are grown mainly for sale are sunflower, simsim, groundnuts and peanuts. Surplus paddy and maize also enter the exchange market. Total production of all these food and cash crops for the year 2010 is estimated at 286,381tons valued at TS 113,932,320,000.00. For details see Appendix 1.

3.1.2.2 Livestock Keeping

Keeping of livestock plays an important role in the culture and economy of the Bahi Swamp area. According to a survey carried out in June 2008, 28 percent of the people kept cattle, 37 percent kept goats, 19 percent kept sheep and 78 percent kept traditional chickens; while less than 10 percent kept other types of livestock like pigs, turkey and donkeys. It is worth noting that all livestock keepers are also farmers; so there are large scale livestock keepers who do very limited farming, but obtain their income by selling their livestock.

The district is estimated to have 133,156 hectares of suitable land for grazing livestock. The estimated number of cattle, sheep and goats and their values in 2010 are as follows: 224,220 cattle valued at 78,477,000,000/= TS; 47,472 goats valued at 1,186,800,000/= TS; and 9,995 sheep valued at 249,875,000/= TS – making a total value of major livestock of 79,913,675,000/= TS. In reality, the total value is expected to be somewhat higher if all marketable animals and birds (including pigs, chicken, etc.) kept were included in the evaluation. For details see Appendix 2.

Plate 3: Livestock Grazing in Bahi wetlands

3.1.2.3 Fishing

Fishing activities are carried out almost through out the year in area, especially at the permanent swamps of Surughai (which covers 290 square kilometers), Nondwa (which covers 243 square kilometers) and

Mchito (a much smaller swamp). During the rainy season, however, fishing is carried out in all the swamps and in the main river Bubu, and, to a lesser extent, in the rivers of Lukali, Kasela and Kambala – all of which are dry at other times of the year.

Most of the fish harvested are processed locally by sun or fire drying. Fish from Bahi is transported to markets as far away as Dar es Salaam, Mwanza and Mbeya and exported to Burundi and the Democratic Republic of Congo. The main species of fish caught in the area are clarias (kambale), tilapia (perege), ningu and sardines.

The fishing industry in the wetlands offers employment to over 1,000 people mostly on a seasonal basis i.e. during the rainy season. The total value of the fishing industry is currently estimated at TS 3,760,500,000/=. For details see Appendix 3.

Plate 4: Fishing in Bahi Wetlands

3.1.2.4 Salt Production

Surughai, the largest swamp in the area, has a number of locations on the edges where salt deposits are found. The popular spots are at Chali Igongo and Naguro in Bahi district and Kinangali in Manyoni district, but salt is also produced in Mpamatwa, Lamaiti, Kigwe and Ilindi wards of Bahi district. Although the salt produced in these areas finds a market as far away as Burundi there are no official records of the levels of production. Our estimates based on the areas we visited suggest that about 4,200 tons of salt valued at TS 294,000,000/= is produced annually in the area. The amount of salt that is produced is constrained by the type of technology used to produce it. Salt is processed by looking for salt bearing sand, mixing the sand in water, decanting the solution, then boiling the salty water until the salt is left in the boiling pans. This process consumes a lot of fuel wood. Much more salt could be produced if the technology was improved. Traditional salt production employs over 5,000 people particularly during the dry season.

Plate 5: Salt Making at Ilindi Village, Bahi Wetland

3.1.2.5 Forest Products

The Bahi swamp area is also rich in forest resources that supplement the livelihoods of surrounding communities. The forests products are estimated at 80,511,897,600/= TS in 2010. A large number of people are engaged in production and trading of forest products, many of which are sold in the region. Dodoma Municipality in particular depends on fuel wood from the area and other goods include non-timber forest products such as building poles, withies, ropes, roofing grasses and reeds. The wetland is also known to provide direct consumable non-timber foods like *ukwaju* (tamarind) and *ubuyu.* These products are also traded with people from outside the area mainly because of their health improvement properties. For details see Appendix 4.

Plate 6: Tamarind and *ubuyu* from Bahi wetlands sold along the Dodoma-Singida road

3.1.2.6 Forest Reserve

Bahi district's 2819 hectares of land is covered with both natural and exotic forests, many of which are harvested and replanted on an annual basis. There are no estimates of the value of these forests. The types of trees that are found in these forests include mipululu, miyombo, mikungugu, mitunduru, mikola, misaim, midoho, mifulu, mikoma, and migunga.

3.1.2.7 Wildlife

The traditional forest reserves of Dangiyo, Goima, Lamaiti, and Chenene are home to a variety of animals including elephants, lions, hyenas, hippopotamus, antelopes, leopards and hares. But these have not been ascribed a commercial value in terms of tourism revenues because they are not found in the official forest reserves.

3.1.2.8 Beekeeping

Beekeeping is carried out on a small scale by individuals using mostly traditional methods. Two types of bees are found in the area – the stinging and stingless bees. Their main products are honey and wax. The total value of beekeeping activities in 2010 is estimated at TS 496,954,800/=. For details see Appendix 5.

3.1.2.9 Commercial Activities

A considerable number of people are engaged in commercial activities for their livelihood. Every village in the area has at least one shop, while large villages like Bahi Sokoni have more than 10 shops. These shops sell everything from clothing to foodstuffs, including those obtained from the nearby environment.

3.1.2.10 Mining

In addition to the production of salt, a number of small scale traditional mining activities for gold and phosphate are undertaken in the Bahi region. Gold mining is carried out at the Mafurungu hills and phosphate mining is carried at Chiwela. There are no records of the amount of either gold or phosphate mined, or the income derived from them. These ventures are generally basic and have limited environmental impact in comparison to the proposed uranium mining.

3.2 Ecological Goods and Services offered by the Bahi wetlands

The Bahi wetland is a shallow ephemeral lake located in central Tanzania. With an irregular cycle of flooding and drying, the spatial extent of the lake varies considerably from year to year. The wetland supports a high level of biodiversity and has been identified as one of the most important wetlands in Tanzania for water birds, meeting the Ramsar 1% criteria for nomination. It is both ecologically and economically important to the country.

There are numerous benefits from the ecological functions of healthy ecosystems. Such benefits accrue to all living organisms, including animals and plants. Bahi wetland offers many and different ecological goods and services - for example its fertile soils, water, and forest cover, to mention a few. Ecological goods and services are often complex, integrated and closely linked with each other. It is, therefore, difficult to fully define and describe in physical or economic terms.

While having significant environmental importance, many of these have no direct economic value, simply because they cannot be sold in markets and we don't yet know how their loss might impact upon local economics. The Bahi Swamp is of great environmental and ecological importance to Tanzania. It supports a high level of biodiversity and has been identified as one of the most important wetlands in Tanzania for water birds. In addition, the Bahi ecology supports a range of human livelihood activities, including cultivation, fisheries, livestock grazing, salt production and the harvesting of natural products – important to the wider Tanzanian economy. However, as population rises, initiatives to increase food security and generate income are also multiplying, placing the ecological services provided by the wetlands under increasing pressure. Even with application of the best possible technology, mining can only exacerbate this pressure.

The ecological goods and services of the Bahi Swamp that are manifest in Tanzania's economic production have already been discussed. The intangible ecological assets – those that cannot be defined in terms of Tanzania's market economy include assets such as plant species that are necessary for stock feed, water quality that is essential to the life of fish and wetland birds like flamingos and the potential value of future tourism. Required for livestock, grasses are one of the key ecological goods provided by the Bahi Swamp. However, their economic value cannot be truly defined; not until they cease to exist. The same applies to the swamp and river waters, where the quality of water is related to the survival of economic resources derived from the various fish species, especially tilapia. Here, too, the true value in market or economic terms can only be assessed by studying the links between fish populations and water quality.

The Bahi wetland has distinctively large populations of water birds that are a good attraction to tourists, especially the greater and the lesser flamingos. An Africa-wide assessment of flamingos indicates that their numbers are declining. Africa's flamingo populations are known to migrate between the soda lakes of Eastern Africa and Southern Africa. Since conservation zones need to stretch across many political boundaries, threats to all key habitats need to be considered if there is to be an attempt to conserve the African flamingos.

CHAPTER FOUR: ESTIMATES OF VALUES OF ECONOMIC ACTIVITIES AND POTENTIAL BENEFITS FROM URANIUM MINING

4.1 Estimates of economic value of major economic activities of the area

Based on the information contained in the preceding chapter, it is estimated that the major economic activities of the Bahi swamp region (on the basis of local farm gate prices for 2010) are worth 278,909,197,400.00/= TS. When spread across the local population of around 300,000 this figure is equal to around 929,697.32 TS or ~$620 USD[1] per person which is just a little bit above the country's per capita income that is normally highly undervalued. For details of the summary see Appendix 6.

4.2 Anticipated Benefits from Uranium Mining

4.2.1 Introduction

We have very scarce information with regard to uranium mining operations of the three companies to enable us derive accurate benefits and costs of uranium mining in the Bahi Swamp area. There are potential benefits in such areas as employment opportunities, royalties paid to the government, and local community benefits that could arise if the companies implemented social responsibility activities. These include (but are not limited to) construction of community facilities such as school buildings, hospital buildings and roads. However, it is difficult to estimate the value of these benefits because they would only be implemented if the company is willing to do so, and if the levels of profits they make are high enough to satisfy shareholders. Other benefits whose monetary value is difficult to estimate include stimulation of the local economy through purchases of inputs (like spares and food from local traders and from the wider circulation of money.

Another benefit would be the imparting of mining skills and technical knowledge to the local people employed in the mining operations. Such skills make the beneficiaries employable where similar operations are undertaken, including other mines which may be opened locally. Should a major mine be opened in the Bahi swamp region, the onus would be on both the mining company and the Tanzanian government to build the capacities of the local people to maximize the benefits from the mining operations.

[1] Based on foreign exchange rate of November 2010 of 1500 TS per 1 $.

4.2.2. Employment

Based on Mantra Resources' plans for the Nyota Project at Mkuju River in Ruvuma Region, it can be assumed that during the mine construction period each uranium mining company will employ about 1,200 persons – although many of these may not be locals. After the construction period, each company will have about 450 permanent staff for up to 12 years. If an average salary of TS 300,000.00/= per month during the first year of the mine construction stage is assumed, there will be an estimated influx to the local economy of TS 12,960,000,000.00/=. In the second year when operations begin and in subsequent years (assuming an average salary of TS 500,000.00/= per month) this should decrease to TS 8,100,000,000.00/= per year.

4.2.1 Royalty

According to the Mining Act of 2010, minerals like uranium attract a royalty fee of 5 percent of the value mined. Based on information on the expected quantity of uranium be mined in the concession areas, the estimated royalties that will be paid to the government by the three companies will be TS 17,212,500,000.00/= per year. For details see Appendix 7.

4.2.2. Corporate responsibility activities

Using an assumption that 1 percent of retained earnings will be set aside for such activities, the estimated amount of money that will be spent by the three companies on corporate responsibility activities will be TS 402,772,500.00/=. For details see Appendix 7.

4.2.3. Estimated production levels and value of uranium in the Bahi Swamp area

Since exploration is the only major uranium mining activity currently being undertaken, it is not possible to estimate how much uranium will be produced by the three companies in the Bahi Swamp area. Only Uranex has indicated the amount of uranium they are expecting to mine at their three identified areas over the lifespan of the mine, assumed to be twelve years. Using these figures, and assuming the other two companies will be able to find deposits that will provide the same yield of uranium (that is, 15.3 million pounds over a period of twelve years), a yield of 1.275 million pounds a year per mine is estimated.

According to the Australian Conservation Foundation 2009, uranium prices fluctuate a lot. For example in December 1999 the average price per pound was US $ 9.60, US $ 20.7 in December 2004, US $ 138 in June 2007and US $ 48 in February 2009. Using the current price of US $ 60 per pound to make calculations in line with information it is estimated that the three companies will realize total revenue amounting to Tanzania Shillings 344,250,000,000.00 (~$250,000,000 USD).

4.3 Cost-benefit analysis

A cost-benefit to Tanzania can be determined by comparing the net present value of the local economy with the net present value of the input from the mining ventures. The estimates provided within this report suggest that the annual value of uranium mining to Tanzania is likely to amount to about 9% of the annual value of the land to the local economy.

This means that if a 1% loss in economic capacity based upon natural and cultural resource management occurred, then the net benefit to the region will have been consumed by the end of the twelve year mining period. Should the loss in capacity be greater, or should a long-term impact occur, then a net deficit will be observed. The size of this net deficit will depend on the physical extent and duration of any contamination observed. The true loss, however, is expected to be considerably greater as a large number of less tangible ecological goods and services that cannot be ascribed a market or economic value may also be lost.

4.4.Uranium Mining Legislation

Tanzania does not have a mining law that deals specifically with uranium. However, the Mining Act No. 14 of 2010, in Part X, titled "Miscellaneous Provisions", refers to radioactive minerals under section 108. Section 108(5) states that "[T]he Minister shall make special regulations for the purpose of ensuring public safety with regard to mining, processing, hauling, transporting, conveying, marketing and disposition of radioactive minerals and such regulations shall not be inconsistent with the Atomic Energy Act and its regulations made there under. Since the Act was passed this year the regulations are yet to be made. Other Acts and policy documents that have a bearing on this issue include The Atomic Energy Act 2002, The Environmental Management Act 2004, The Village Land Act 1999, The Forest Act 2006, The Wildlife Act 2009, The Water Act 2003, The National Environment Policy 1997, Water Policy 2002, CITES and Ramsar Convention.

The fact that there is no specific act that deals with uranium mining in the country and the fact that the regulations relating to the Mining Act 2010 have not yet been completed puts the country in a precarious position because the country may be exposed to substantial radiation risk while getting very limited benefits. The benefits may be very limited because of lack of regulatory powers that could force the uranium mining companies to comply with international best practices in uranium mining.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion.

The Bahi Swamp area or wetland is home to a population of about 270,000 persons who earn their livelihood by carrying out various economic activities, including farming, livestock keeping, fishing, salt making, and harvesting of various forest products like timber, fuel wood, building poles, charcoal and honey. The area is rich in natural resources that are used widely, and contributes significantly to the economy of the Bahi region. The estimated annualized local market value for the Bahi wetlands for 2010 is TS 283,783,232,400/= (US$193,800,000). This estimate does not include the contributions from intangible ecological goods and services, or scientific and tourism values.

Evidence suggests that uranium exists over the whole of Bahi District and the five wards of Manyoni District. The Tanzanian Government appears ready to permit international companies to explore this area for uranium. The net benefit to Tanzania for the three planned mining projects is estimated to be approximately TS25,700,000,000 /=(US$17,500,000) per annum –about 9% of the current market value of local produce.

While mining uranium *per se* may not be an issue of grave concern,), the radioactive nature of the mineral poses serious ecological challenges, especially in a socio-economically important area like Bahi Swamp. These concerns are not misplaced. With a population density of about 40 persons per sq. km, the Bahi Swamp area is home to a large number of people. The area has more than 40 rivers and more than forty swamps. So local inhabitants are naturally concerned that radionuclides released through mining will be easily transported by underground and surface water and into the food chain. This could occur through eating the meat of animals fed on contaminated grass, eating food that grown on contaminated land drinking contaminated water, or inhaling radioactive dust.

Furthermore, forced relocation of a large part of the local population may be required should the land and local economy suffer from long-term radionuclide contamination. This begs questions about where they would be relocated, and if they would be able to continue earning a living from their natural resource base. Given that Dodoma Region is semi arid, it is highly doubtful that an equally good place would be found for the people living in the Bahi Swamp area. This means that current economic activities that enable the residents to feed themselves and sell surplus outside the area would cease.

The low value of the returns to Tanzania from uranium mining means that adequate compensation is to local communities is unlikely. The greater benefits of uranium mining would accrue to the mining companies while significant valuable local economic activities is lost. The local people could be left with a sad legacy of radionuclide leakage from the tailings dams for many years to come.

5.2 Recommendations

This study has identified economic activities and their values that may be lost or diminished through the mining of uranium in the Bahi Swamp. It has also estimated the financial benefits associated with uranium mining to the Tanzanian economy, in an attempt to determine whether uranium mining is really beneficial in the long-term to residents of the Bahi region. We conclude that there is a serious risk and high probability that the costs to the local and Tanzanian economy will by far exceed the benefits.

We therefore recommend that:

a. The Tanzanian government reconsiders its decision to allow uranium exploration in the Bahi Swamp area. The Bahi Swamp area should be left intact, without uranium mining and contamination. It could be developed into a tourist attraction spot, in addition to developing the current economic activities;
b. In the event that the Tanzanian government allows mining of uranium in the Bahi Swamp area, it should ensure that anyone who removed or forced to move from their areas of livelihood get fair compensation;
c. The Tanzanian government should develop its own capacity to make strong regulations and to supervise implementation of the strong regulations that govern the mining of uranium in the country;
d. In order to be able to monitor levels of radiation after the mining companies have started to mine uranium, the Tanzanian government should determine the levels of radiation before the companies start mining uranium in the area.

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Appendices

Appendix 1: Table 4.1: Estimated crop production in tons and value for 2010

Crop	Farm gate price TS/Kg	Average yield (based on 2003/04- 2005/06) in tons	Estimated Yield in 2010 (20% Increase)	Estimated Income 2010 (TS)
Millet	400	36,142.00	43,370.40	17,348,160,000.00
Sorghum	400	28,926.00	34,711.20	13,884,480,000.00
Maize	300	30,379.00	36,454.80	10,936,440,000.00
Paddy/Rice	600	12,329.00	14,794.80	8,876,880,000.00
Cassava	200	72,367.00	86,840.40	17,368,080,000.00
Potatoes	200	5,804.00	6,964.80	1,392,960,000.00
Legumes	600	5,026.00	6,031.20	3,618,720,000.00
Peanuts	400	3,861.00	4,633.20	1,853,280,000.00
Groundnuts	800	31,596.00	37,915.20	30,332,160,000.00
Sunflower	400	5,758.00	6,909.60	2,763,840,000.00
Simsim	800	5,436.00	6,523.20	5,218,560,000.00
Grapes	300	511.00	613.20	183,960,000.00
Pegion peas	250	516.00	619.20	154,800,000.00
Total				**113,932,320,000.00**

Assumptions:

1. 15 Percent of total production is marketed i.e TS 17,089,848,000.00
2. An increase in production of all the crops of 20 percent over the averages of 2003/04-2005/06 production levels.

Appendix 2: Table 4.2: Estimated Livestock and value 2010

Ward	Cattle			Goats			Sheep		
	2006	2010	Value (2010)	2006	2010	Value (2010)	2006	2010	Value (2010)
chipanga	9,161	10,993	3,847,550,000	1,932	2,318	57,950,000	551	661	16,525,000
Mpalanga	8,219	9,863	3,452,050,000	1,998	2,398	59,950,000	711	853	21,325,000
Nondwa	16,649	19,979	6,992,650,000	2,822	3,386	84,650,000	682	818	20,450,000
Chali	13,471	16,165	5,657,750,000	3,382	4,058	101,450,000	655	786	19,650,000
Chikola	344	413	144,550,000	344	413	10,325,000	344	413	10,325,000
Mpamantwa	12,196	14,635	5,122,250,000	2,661	3,193	79,825,000	283	340	8,500,000
Kigwe	8,927	10,712	3,749,200,000	2,381	2,867	71,675,000	394	473	11,825,000
Ibihwa	6,829	8,195	2,868,250,000	1,352	1,622	40,550,000	183	220	5,500,000
Ilindi	6,077	7,292	2,552,200,000	1,620	1,944	48,600,000	288	346	8,650,000
Bahi	11,444	13,733	4,806,550,000	1,313	1,576	39,400,000	422	506	12,650,000
Mundemu	7,767	9,320	3,262,000,000	2,106	2,527	63,175,000	313	376	9,400,000
Msisi	12,124	14,549	5,092,150,000	3,185	3,822	95,550,000	387	464	11,600,000
Babayu	9,350	11,220	3,927,000,000	1,498	1,798	44,950,000	289	347	8,675,000
Lamaiti	11,723	14,068	4,923,800,000	1,473	1,768	44,200,000	290	348	8,700,000
Makanda	6,810	8,172	2,860,200,000	970	1,164	29,100,000	237	284	7,100,000
Mayamaya	9,056	10,867	3,803,450,000	2,474	2,969	74,225,000	623	748	18,700,000
Chibelela	14,522	17,426	6,099,100,000	3,948	4,738	118,450,000	858	1,030	25,750,000
Mtitaa	9,817	11,780	4,123,000,000	1,539	1,847	46,175,000	300	360	9,000,000
Ibugule	7,314	8,777	3,071,950,000	1,370	1,644	41,100,000	185	222	5,550,000
Mwitikira	5,051	6,061	2,121,350,000	1,183	1,420	35,500,000	333	400	10,000,000
Total	**198,320**	**224,220**	**78,477,000,000**	**41,449.00**	**47,472**	**1,186,800,000**	**8,328**	**9,995**	**249,875,000**

Assumptions:

1. Livestock increase of 20% in 2010
2. Average prices; cattle – 350,000/=
   Goats – 25,000/=
   Sheep - 25,000/=

All values are auction prices given in Tanzania Shillings.

Appendix 3: Table 4.3 Estimated harvests of fish and value (tons)

Type of fish	2007/08	2009/2010	Income
Clarias (Kambale)	933.00	1,026.30	1,539,450,000.00
Tilapia (Perege)	1,326.00	1,458.60	2,187,900,000.00
Ningu	12.00	13.20	19,800,000.00
Sardines (dagaa)	8.00	8.80	13,200,000.00
Total	**2,279.00**	**2,506.90**	**3,760,350,000.00**

Assumptions:

1. Increase in fish catches of 10%
2. Fish prices of Tshs 1,500/= per

Appendix 4: Table 4.4: Estimated amounts of forest products for 2007 and 2010

Products/Year	Quantity (m3) 2007	Quantity (m3) 2010	Value 2010 (TS)
Fire wood	3,443,821	4132585.2	24,795,511,200.00
Charcoal	4,389,390	5267268	31,603,608,000.00
Timber	1,300,647	1560776.4	9,364,658,400.00
Poles	2,048,350	2458020	14,748,120,000.00
Total			**80,511,897,600.00**

Assumption is that harvesting of forest products has gone up by 20 percent in 2010. The value of forest products that are related to harvesting forests is estimated at **80,511,897,600/=** TS.

Appendix 5: Table 4 5: Estimated Productions of Honey and Wax for 2010

Product	2007	2010	Amount(Tshs)
Honey (Litres)	115,455.00	138,546.00	346,365,000.00
Wax (Kgs)	83,661	100,393.20	150,589,800.00
Total			**496,954,800.00**

Assumptions

1. An increase of 20 percent over 2007 production levels
2. Farm gate price for honey is 2,500/= per litre.
3. Farm gate price for wax is 1,500/= per Kg.

Appendix 6: Table 4.6: Summary of Estimates of the Economic Value of Major Economic Activities of the Bahi Swamp area for 2010

S/N	Major Economic activity	Value (Tshs)
1	Agriculture	113,932,320,000.00
2	Livestock keeping	79,913,675,000.00
3	Fish harvesting	3,760,350,000.00
4	Salt production	294,000,000.00
5	Forest products	80,511,897,600.00
6	Honey and wax	496,954,800.00
	Total	**278,909,197,400.00**

Appendix 7: Estimates of benefits from uranium mining

The cost of producing one pound of uranium (U238) has been estimated by Mantra Resources for their Nyota project (Mkuju River) at US $ 25.05. This will result in gross profit of US $ 34.95. If we assume that other costs will be 60 percent of gross profit (i.e US $ 20.97) will get a net profit of US $ 14.04. If we allow dividends to take up 50 percent of net profits we will be left retained earnings of US $ 7.02 per lb. If it is the policy of the company to spend 1 percent of retained earnings on corporate responsibility then they will spend US $ 0.0702 per lb. With total annual production of 1.275 million pounds of uranium it means they will spend US $ 89,505 or Tshs 134,257,500/=per year per company. For the three companies total expenditure on corporate responsibility will be 402,772,500/= per year.

Revenue/costs for the three uranium mining companies in Bahi Swamp area (Mill Tshs)

Year	Revenue	Costs/Labour
1	0	12,960
2	344,250	8,100
3-13	Same each year	Same each year
Total	4,131,000	110,160

9.4.2 Employment benefits

Employment benefits over a 13 year period of operation will be Tsh 110,160 million for 3,600 workers for the first year and for 1,350 workers for 12 years.

9.4.3 **Government royalty**

On the basis of a 5 percent royalty fee to the government it will receive Tshs 17,212.5 million per year or a total of 206,550 million Tshs over a period of 12 years.

9.4.4 **Corporate responsibility**

Corporate responsibility expenditure of 1 percent of retained earnings the community will receive Tshs 402,772,500/= per year or a total of Tshs 4,833,270,000/= over a period of 12 years.

Summary of Financial Benefits to the Economy and to some Members of the Bahi Swamp Area.

Financial benefits	Income (Million Tshs)
Employment	110,160.00
Government royalty	206,550.00
Corporate responsibility	4,833.27
Total	**321,543.27**

Balance

Description	Mill Tshs
Community loss of the same value over 12 years	3,345,705.60
Companies' revenue	4,131,000.00
Economy gain	321,453.27