WATER CHALLENGES IN THE MINING INDUSTRY: EXAMPLES FROM AFRICA

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Enhancing Water Management Capacity in a Changing World:

Science Academies Working Together to Increase Global Access to Water and Sanitation

Sao Paulo, Brazil, 25-28 June 2012

INTRODUCTION

- Water links Africa's economic fortunes and climate change challenges.
- Water resources contribute enormously to economic productivity and social well being of the human populace as both social and economic activities rely heavily on the quantity and quality of water.
- With the increasing growth in population and the subsequent socio-economic pursuits (including urbanization, industrial production, tourism and agricultural activities) demand for water has increased rapidly (WWAP 2006).

AFRICA'S MINERAL RESOURCES

- Africa is well endowed with mineral resources: it harbours the world's largest mineral reserves of platinum, gold, diamonds, chromite, manganese, and vanadium (ECA 2009).
- Thus, mining plays a crucial role in many African economies, accounting for more than half of export earnings in seven - from 50% in Sierra Leone to 85% in Guinea (World Bank 2002).
- In some countries, such as Botswana, mining accounts for a third of GDP, and it also accounts for a significant percentage of GDP in South Africa and Namibia (ECA 2004).

MINERAL	AFRICAN Percent OF WORLD PRODUCTION	RANK	AFRICAN Percent OF WORLD RESERVES	RANK
Platinum Group Metals	54 Percent	1	60+ Percent	1
Phosphate	27 Percent	1	66 Percent	1
Gold	20 Percent	1	42 Percent	1
Chromium	40 Percent	1	44 Percent	1
Manganese	28 Percent	2	82 Percent	1
Vanadium	51 Percent	1	95 Percent	1
Cobalt	18 Percent	1	55+ Percent	1
Diamonds	78 Percent	1	88 Percent	1
Aluminium	4 Percent	7	45 Percent	1

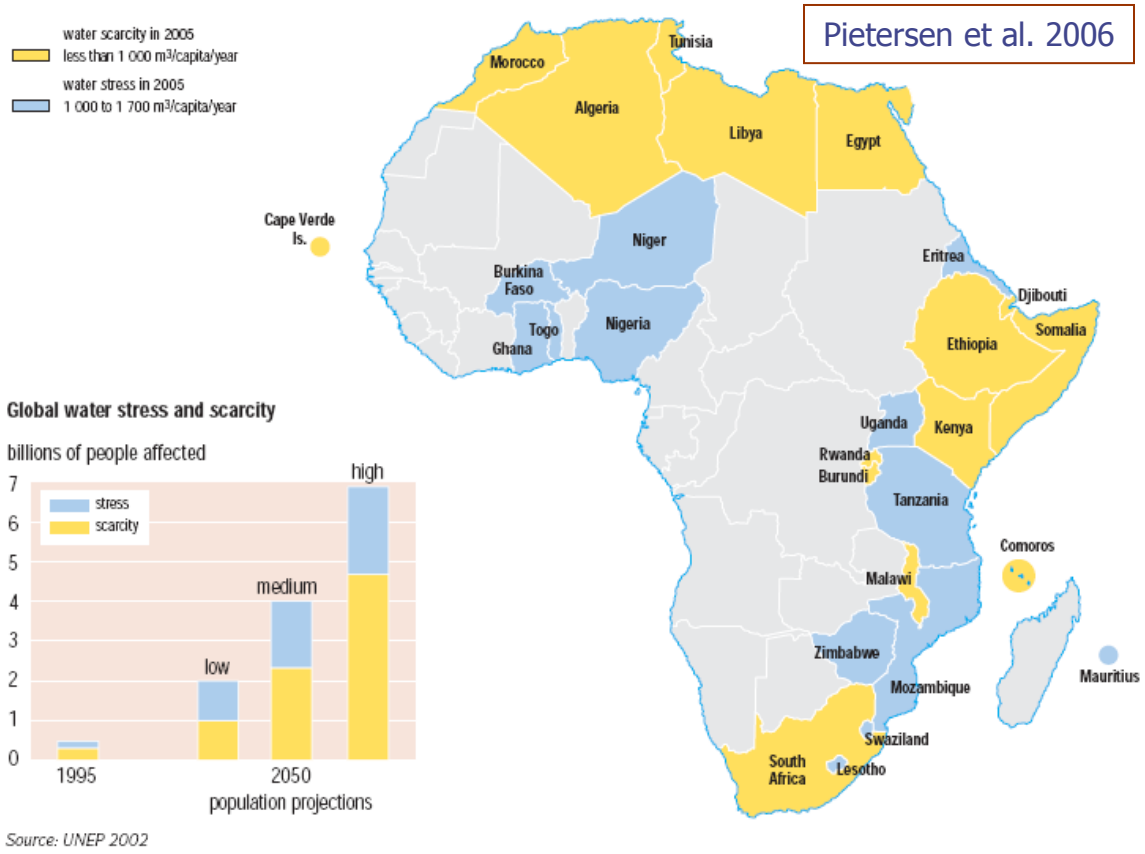
ECA 2009

WATER USES IN THE MINING INDUSTRY

- Mining (blasting, waste removal and ore extraction) - water is used in the pit to dampen dust created by mining activities to extract ores. It aids visibility and reduces risks to health.
- Processing (crushing) - water is not used here, but ore optimization – crushing the ore to the best size for extracting minerals, reduces the amount of water needed later.
- Scrubbing/washing - scrubbers 'wash' the crushed ore in preparation for filtering. Saltwater, or water recovered from the pit sump or other sources may be used.
- Screening - Crushed ore is washed and screened. Small pieces pass straight through, while larger pieces go through another round of crushing, scrubbing and filtering.
- Separation - the screened and washed material is separated out and water recovered from this process is either recycled or treated according to environmental standards and discharged back into natural water sources.
- Secondary processing in plants

COMPETING NEEDS FOR (FRESH)WATER

- Freshwater is a necessary input for industry and mining, hydropower generation, tourism, subsistence and commercial agriculture, fisheries and livestock production, and tourism.
- These activities are central to livelihoods and human well-being

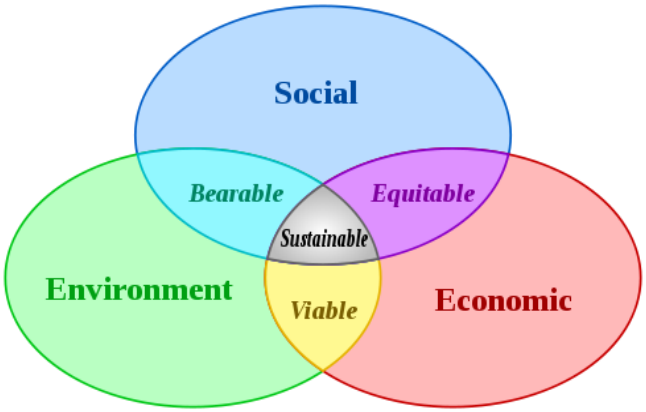


- This demands that water be managed as part of a healthy functional ecosystem, in order to ensure it continues to deliver essential environmental goods and services (Pietersen et al., 2006), particularly since many of the countries that are water stressed or water scarce e.g. Kenya / Tanzania, are also rapidly ramping up their mineral prospecting and production as well as having recently discovered potentially or commercial oil and gas prospects.

SUSTAINABLE DEVELOPMENT AND MINING

- Mining sustainability can be ensured by the linkages (downstream, upstream and sidestream) it forms with other sectors of the economy (ECA 2009), including the water sector, and social and environmental aspects
- The Johannesburg Declaration created "a collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development at local, national, regional and global levels" (WSSD 2002)

- mining could be a key instrument in establishing infrastructure (transport, energy and water) for the development of other sectors, such as agriculture and forestry:
- this is embodied in the NEPAD Sustainable Development Programme (SDP) initiative and in the Africa Mining Vision (AMV) (ECA 2009)

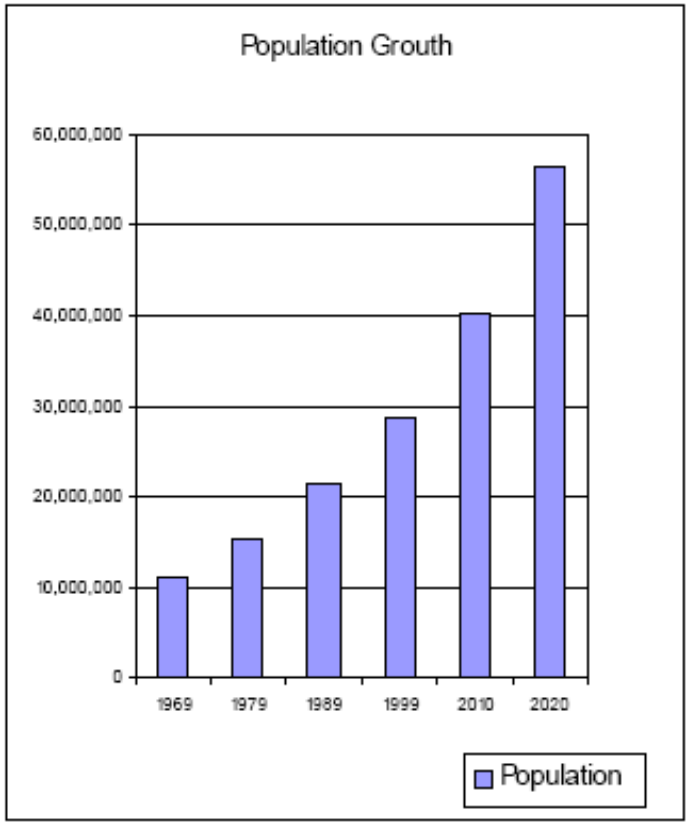


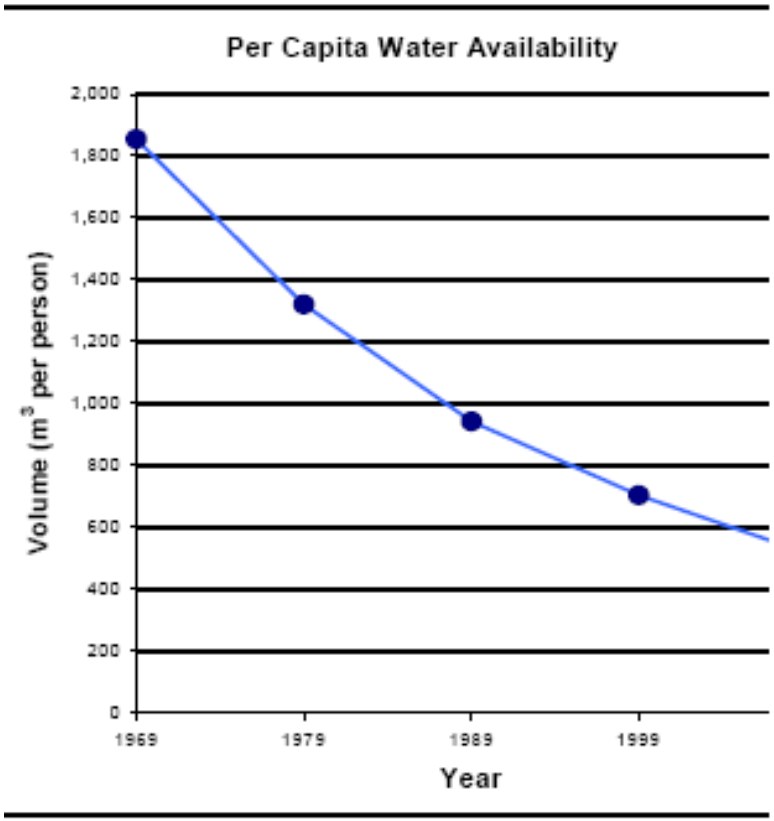
Johann Dréo, 2006 - Wikipedia

- Africa Mining Vision (AMV) - advocates for "transparent, equitable and optimal exploitation of mineral resources to underpin broad-based sustainable growth and socio-economic development"

WATER DEMAND - 1

- Climate variability and increasing demand for water as a result of development and population pressure are factors that have increased water demand for domestic use, food security and industrial development. In Kenya, the population growth trend has resulted in reduction of per capita water availability.





WWAP, 2006

WATER DEMAND - 2

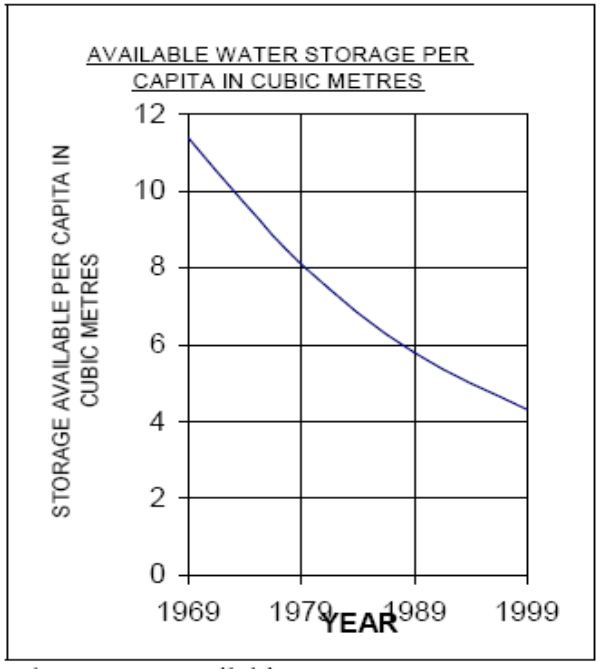
- In Kenya, the estimated water demand shows that industry is lumped with other low volume uses of water, as compared to high water uses - irrigation (agriculture) and livestock
- This study, which was conducted in the 1990s, did not foresee the current rapid growth in the mining sector and hence its rapidly increasing demand for water (both Kenya and Mozambique have found rich deposits of titanium-containing sands in beach and inshore dunes), as well as the possibility then (and now fact) of having potentially viable commercial deposits of oil and gas which would require a higher use of water from industry than was projected.

Category	**Demand (1,000 m^3/day)**	
	1995	2010
Residential urban	747.8	1,642.8
Residential rural	468.2	932.6
Sub-Total	**1,216.0**	**2,575.4**
Non-residential, health facilities, schools, industry and commerce	593.9	986.3
Total	**1,809.9**	**3,561.7**
Livestock water	376.6	621.4
Irrigation	3.9M	8.1M
Grand Total	**2,186.6**	**4,183.2**
Source: Ministry of Water and Irrigation		

WWAP, 2006

WATER STORAGE AND DELIVERY INFRASTRUCTURE

- Water storage capacity in Africa is generally low
- In Kenya, there are presently 26 large dams and about 3,000 small dams and water pans with a storage capacity of approximately 124 million cubic meters (WWAP 2006).
- The storage capacity has been low due to the fact that investment levels in water management infrastructure have been inadequate and have been on a declining trend for many years.
- The water delivery infrastructure is also deficient



Summary of Urban and Rural Water Supplies (from IEA, 2006).

Water Service Boards	Board Area population	Urban Population Served (%)	Rural Population Served (%)	Total Population Served (%)	Total Unserved (%)
Athi	5,617,220	37.4	4.9	42.3	57.7
Lake Victoria South	5,730,956	7.4	12.5	19.9	80.1
Lake Victoria North	5,135,894	11.5	6.8	18.3	81.7
Tana	5,012,208	10.2	44.2	54.4	45.6
North	1,703,695	12.0	31.3	43.3	56.7
Rift Valley	2,999,370	11.5	6.9	18.4	81.6
Coast	2,487,264	12.7	4.4	17.1	82.9
Totals	28,686,607	15.6	15.4	31.0	69.0

WATER QUALITY AND POLLUTION

- The potential impacts of mining on the water environment are subdivided into those associated with phases of mining operations, namely (Oelofse, 2008):
  - ⇒ The act of mining itself;
  - ⇒ Seepage of contaminated water from mine residue deposits (waste rock dumps and tailings dams) resulting from mineral processing/beneficiation;
  - ⇒ Dewatering of active mining operations; and
  - ⇒ Rewatering (flooding) of defunct/closed mine voids and discharge of untreated mine water.

MINING IMPACTS ON WATER RESOURCES

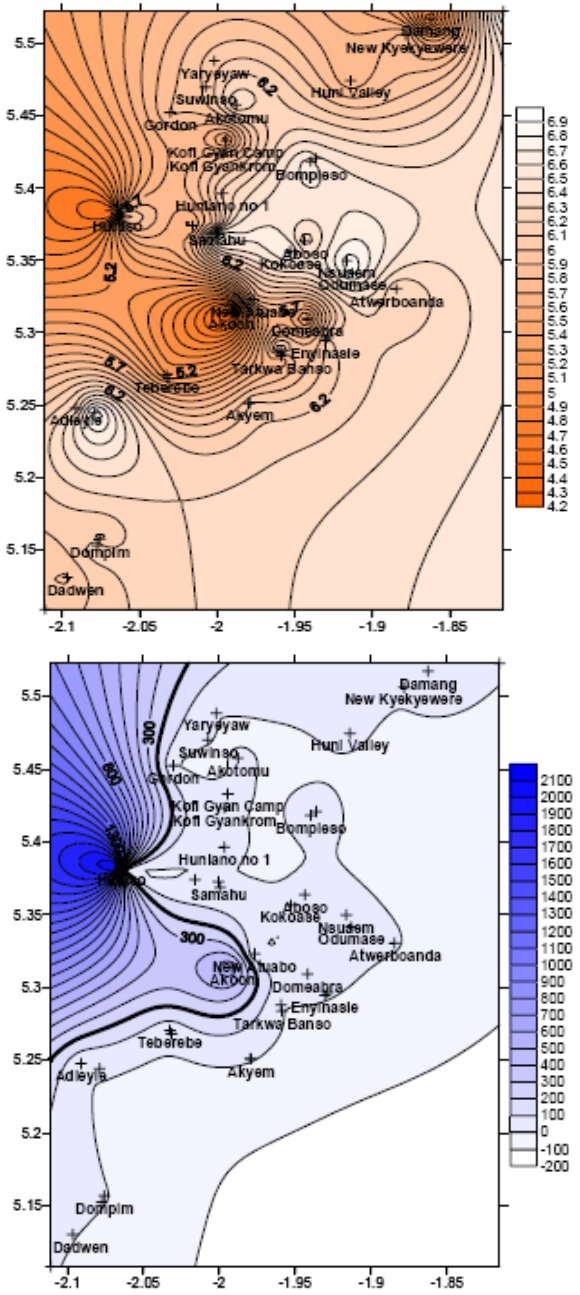
POLLUTION IMPACTS
Drainage from sites (acid mine drainage and mine water)
Sediment runoff from mining sites
Pollution from mining operations in riverbeds (dredging)
Effluent from mineral processing operations
Sewage effluent from the site
Oil and fuel spills
Soil contamination from treatment residues and spillage of chemicals
Leaching of pollutants from tailings and disposal areas and contaminated soils
Noxious emissions from minerals processing operations
Dust emissions from sites close to habitats
Release of methane from mines
Destruction of potable water sources and/or river sources
Pollution of groundwater and surface water by mineral processing effluent and raw sewage
Heavy metal and hydrocarbon pollution
Artisanal workings are potential sources of low pH, high iron and high mercury seepage
Sulphate, in many arid environments, can become the dominant contributor to salinity in the vicinity of the discharge (Bowell 2000)
Corrosive effect of high sulphate waters, particularly towards concretes (Bowell 2000)

CASE STUDY 1 – GOLD MINING IN GHANA

- Pollutant sources from large scale gold mines, western Ghana, were identified as follows (Asklund and Eldvall 2005):
  - ➔ AMD (Acid Mine Drainage) from solid waste from sulphidic ore leaching heavy metal and acidity into water and soil.
  - ➔ Grease and oils from various activities in the mines
  - ➔ Roasting of ore containing pyrite gives a rise to the production of SO_2 in the atmosphere which produces acid rain. The acid water then releases high levels of toxic ions from the rock matrix in the groundwater.
  - ➔ Impact due to processing technique includes contamination of water bodies and soil by release of cyanide, arsenic, sulphates, and heavy metals as Pb, Cu, Zn and Fe
  - ➔ Cyanide spillage. There have been a number of accidental cyanide spillages in Ghana. The major spillages occurred in 1989, 1991, 1994, 1996, 1999 and 2001.

CASE STUDY 1 – GOLD MINING IN GHANA

- Pollutants from small scale gold mining were identified as follows (Asklund and Eldvall 2005):
  - Pollution of rivers and streams by mercury
  - Mercury in groundwater from accidental spillage during gold processing (Akosa et al.2002)
  - AMD from solid waste from sulphidic ore leaching heavy metal and acidity into water and soil (Akosa et al. 2002)
  - Siltation of surface waters (Akosa et al. 2002)
  - Estimated 5 tonnes mercury is released from small-scale mining operations in Ghana each year (Hilson 2001).
  - High concentrations of mercury have been found in sediments and fish in the vicinity of small-scale mining activities using amalgamation as their main technique.



CASE STUDY 2 – GOLD MINING IN TANZANIA

- Pollutant sources from large scale gold mines in Tarime District, North Mara, were identified as (SID 2009):
  - ➔ poor sanitation, lack of clear and safe drinking water, high congestion, and poor hygiene.
  - ➔ At Barrick mining site in North Mara the tailings dam runs freely into the pastures and fields used by the local population and the heavily contaminated waters from the processing plant, leaking into their water sources, adversely affect them and their livestock.
  - ➔ Levels of nickel have risen 260 times, levels of lead are up 168 times and chromium levels have also multiplied by 14 compared to the last time tests were conducted in the area about seven years ago.
  - ➔ Panning and sluicing requires a lot of water, which is drawn from existing rivers that are also sources of water for domestic use in the mining centre.

CASE STUDY 2 – GOLD MINING IN TANZANIA

- Pollutant sources from small scale gold mines were identified in Rwamagasa village as (SID 2009):
  - ➔ The extraction of the gold with mercury releases large amounts of toxic liquid mercury fumes into the local environment.
  - ➔ There is no clean and safe drinking water, no waste disposal for the toxic mercury or any other waste or human discharge.
  - ➔ Miners working for many years in the amalgamation or smelting process showed severe symptoms of mercury intoxication, and the exposure of the whole community to mercury is reflected in raised mercury levels in the urine, and early symptoms of brain damage like ataxia, tremor and movement disorders.
  - ➔ Hygienic standards are extremely low and are the cause of many infectious diseases such as diarrhoea, typhoid and parasitism.

CASE STUDY 3 – COAL MINING IN SOUTH AFRICA

- South Africa is the third-biggest coal producer in the world.
- The majority of the coal mines in the Olifants river basin occur in the Witbank area, at the head of the Olifants River (Aston, 2000).
  - ➔ Over the years, runoff from these mines has had adverse affects on the quality of the surface water though it has become more and more controlled: now the water pumped from the mines must be treated before it may be put into the river system and there is a pilot project underway that is using this mine water (with neutralised pH) as irrigation water (Aston 2000).
  - ➔ As mines close and pumping stops they become filled with highly acidic mineralised water which can have a direct affect on the regional groundwater quality when there is an aquifer adjacent to a mine
  - ➔ Treatment is required to some degree, but the chances are that less treatment would be required if the water were to be used for certain irrigation rather than allowed to overflow from the mines into the natural water system.

WATER CONFLICTS

- In some areas of Kenya, a stage has reached where availability of water is the limiting factor for any development activities: in such areas conflicts have risen amongst the various competing sectors and users of water (WWAP 2006).
- In South Africa, Aston (2000) states that if a significant portion of the population remains without access to potable water and the mining industry continues to visibly pollute and modify the water table without consequence, the government risks losing its legitimacy, with potential knock-on effects such as loss of foreign direct investment in South African industries to social unrest, or even civil war.
- The new Titanium mining company in Kenya has to go back to the drawing board for alternative source of water supply after residents rejected the withdrawal of water from a nearby perennial river.

ENVIRONMENTAL STEWARDSHIP

- Environmental and social impact assessments (ESIA) has partly benefited from companies subscribing to international standards (e.g. UN Global Compact, the Global Reporting Initiative, the IFC Performance Standards, the Equator Principles) hence improving corporate social responsibility
- Also, communities around mining areas have a newly found sense of entitlement and increasingly demand economic benefits, a healthy environment and respect for human rights around resource extraction areas (ECA 2009).
- Water is often a major, if not the major, issue facing a mine or milling operation (Bowell 2000). It is, therefore, important to seek for alternative water sources. For example,
  - rainwater harvesting systems
  - Recycling of sewage effluent from towns used in mineral processing plants
  - Rain and groundwater that collects in mine pits can be pumped out for use at the processing stage.

GOVERNANCE AND MANAGEMENT

- Many African countries have undertaken recent reforms in the water sector with a view to streamlining water management, enhancing its availability and quality, as well as protecting the resource.
- Expected outcomes of Kenya 2002 water reforms are:

Policy Formulation	• Improved coordination in Water Sector under one Ministry • Clear policy accountability • Focused attention to water resources management
Regulation	• Clear regulatory framework • Coordination of the management of water resources • Performance monitoring and evaluation • Improved performance of water-undertakers
Service Provision	• Improved management , conservation, and protection of water resources (Quality and Quantity) • Rational allocation of water resources • Ability to attract and retain skilled manpower • Efficient provision of services leading to self sustainability • Improved service delivery • Increased coverage • Ability to attract investments • Improved infrastructure

CONCLUSIONS

- Address the challenge of lack of adequate human (technical and managerial), financial and material resources water authorities face, in particular as this relates to planning and implementing water and sanitation policies and programmes, and water allocation.
- There is generally a lack of know-how and institutional "strength", particularly in the area of IWRM/ILBM, and this has limited the success of water resource management initiatives.
- Research is also essential if African countries wish achieve their long-term development targets, investigating issues such as: concise assessment of groundwater aquifer characteristics; the application of appropriate and modern technology in WRM, and effective and efficient methods of catchment protection, pollution control, conservation and water use efficiency.
- Long-sighted businesses in Africa are already engaging with the challenges posed by water scarcity and stress: in addition to securing water required for operations, businesses will increasingly need to engage on broader water challenges to maintain a social licence to operate, and support the generation and growth of dynamic markets (de Beers 2011).

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