

**SCIENCE IN SERVICE OF SOCIETY**



**AFRICAN SCIENCE COMMUNICATION  
CONFERENCE**

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**MIDRAND, SOUTH AFRICA**

# AFRICA - Wealth Creation & Poverty Reduction



## Leading R&D (STI) fields in the 21<sup>st</sup> Century:

- **Agricultural Technologies & Industries**  
(i.e., Seed Research & Development)
- **Science of Climate Change & Adaptation**
- **Life & Health Sciences**
- **Earth Sciences & Earth Resources** (e.g., water & minerals)
- **Energy Resources**  
(i.e., Renewable Energies & Coal)
- **Space Science & Technologies**
- **Information and Communication Technologies**
- **Biotechnologies & Nanotechnologies**

# Energy Resources in Africa



## Classical/Primary sources:

- ◆ **Oil** – about 10% of the world’s reserves (**New Discoveries:** Sudan, Kenya, Uganda, Tanzania, Zambia)
- ◆ **Natural Gas** - about 8% of world’s reserves, to last >50 years (Egypt: 100 yrs)
- ◆ **Coal** – about 6% of world’s reserves, to last >300 years (Tanzania: >500 million tons)
- ◆ **Nuclear- Uranium** reserves to last >100 years
- ◆ **Hydro-power:** about 12% of the world’s total  
African Drainage Systems (Rivers), e.g. River Congo

## Other major sources:

- ◆ **Bio-fuels**, e.g. Mauritius: 20% from sugar cane (bagasse for electricity)
- ◆ **Solar**
- ◆ **Wind**
- ◆ **Geothermal:** Kenya – about 25% of the total electricity consumed
- ◆ **Ocean** – (a) waves/tides, and (b) hydrocarbons on the sea-bed
- ◆ **Hydrogen**

# Electricity Demand (Africa)



ca. 75% of sub-Saharan Africa has no access to electricity

ca. 9% of North Africa & Middle East have no access to electricity

Required (Africa): **260, 000 MW**

↳▶▶ **Hydro-power potential: ca. 4,000 TWh/yr**

◆ **ca. 2% exploited**

**Geothermal potential: 140, 000 MW**

◆ **<10% exploited**

**Investment Required by 2030**

↳▶▶ **US\$ 560 billion**

◆ **US\$ 4 billion annually to achieve 48% electrification by 2030**

# BIOENERGIES FOR AFRICA



## Types of Bioenergies:

- ◆ **Bioethanol** (Brazil produces 35% of the world's ethanol)
- ◆ **Biodiesel**
- ◆ **Biogas**
- ◆ **Biomass**

## ↳↳▶▶▶ **Research on Bioenergies & Biotechnologies**

- ◆ **Improvement on plants for bioenergies**
- ◆ **Bioenergy Science & Technology**  
i.e., Alcohol Chemistry, Bio-refinery,  
Bioenergy Engines

## **BRAZIL: Bioenergy Research Programme (BIOEN):**

↳↳▶▶▶ **US\$ 130 Million for next 5 years**

# Very low utilization of Africa's enormous Energy Resources:

↳↳▶▶▶ **challenges:**

**Energy Experts**

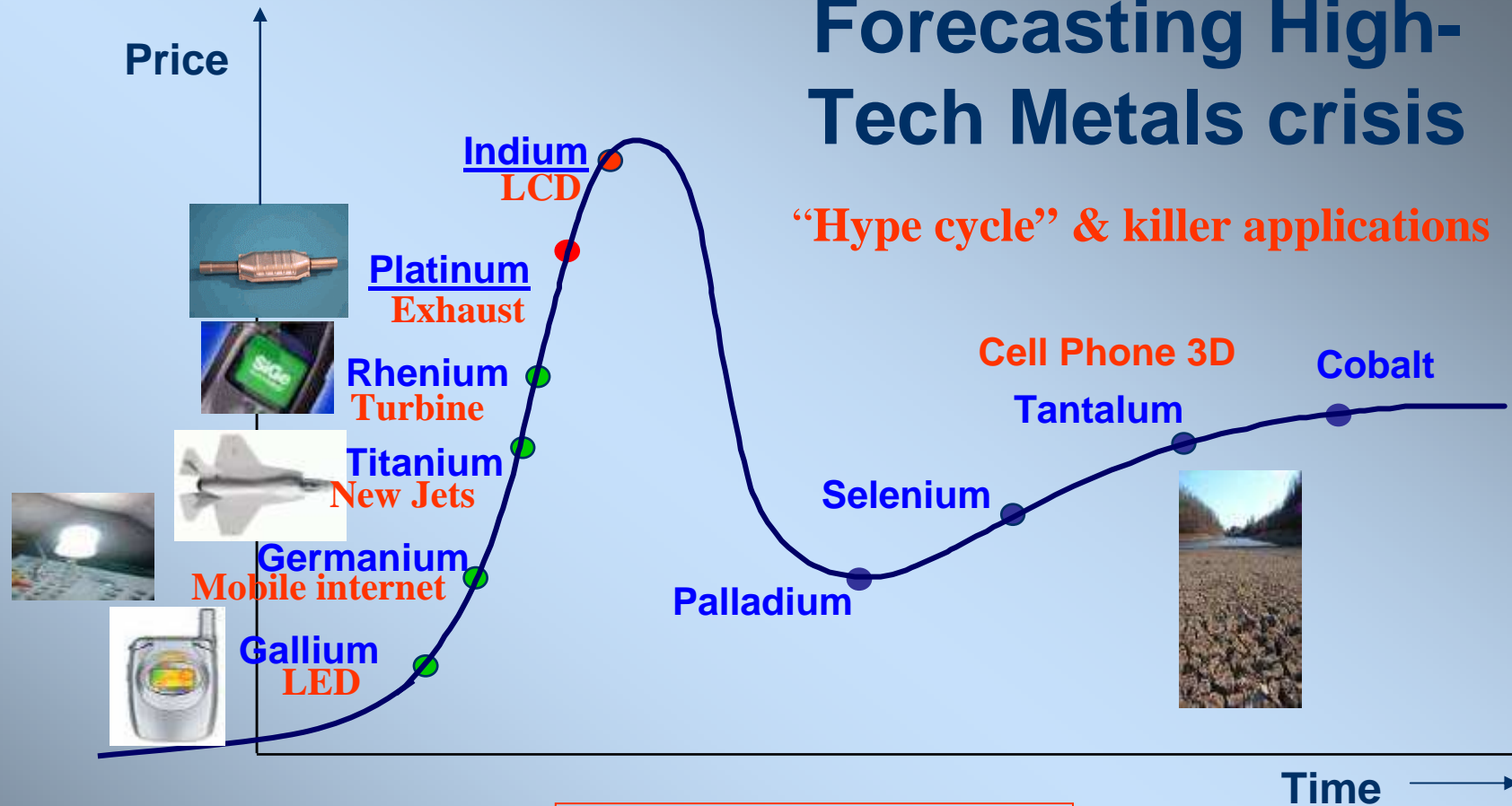
**Energy Policies**

**Energy Knowledge & Technology**

**Investment Capital**

# Forecasting High-Tech Metals crisis

“Hype cycle” & killer applications



Crisis Forecasting

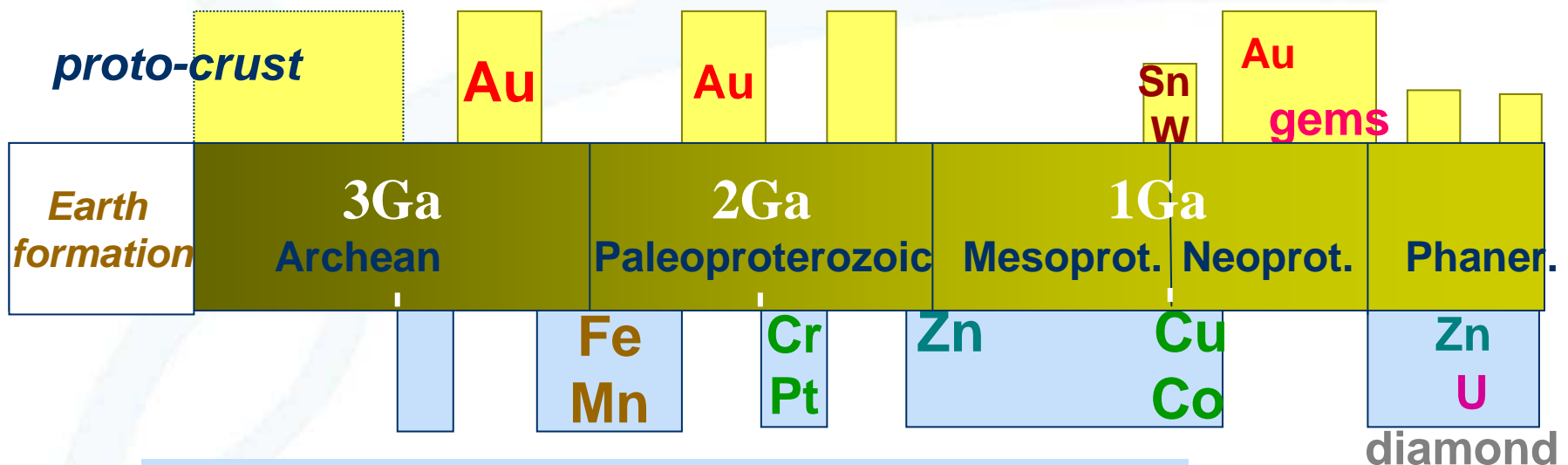
- 0 - 2 years
- from 2 to 5 years
- Post-crisis

# Evolution of the African crust over the last 3.5 Ga



## Dominant crustal accretion / convergence

(active margin-type & orogenic mineral deposits:  
e.g. gold, tin, wolfram, precious stones)



## Stabilisation / breakdown / extension

(basin related & anorogenic mineral deposits:  
e.g. iron, oil, diamond, chromium, platinum)

# SRTI in China



## China's Fast-Track Science Plan:

### **5-year Key Technology Research Development Program**

- ◆ **Efficient Energy & Resources Utilization**
- ◆ **Agricultural Technologies**
- ◆ **Technologies for the Information Technology Sector and for the Manufacturing Equipment**
- ◆ **Population, Health and Public Security**

**Investment: US\$ 2.5 Billion in 5 years (Private & Public Partnership)**

**Sources of Funding: (a) Central Government – US\$ 925 Million,  
(b) Local Government (c) Business & Research Institutions**

# Investment in KSTI: Global partnership



## In 2006 USA: Expenditure on R&D

### Estimated Total: US\$ 340 billion

18% (US\$ 62 billion): Basic Research

22% (US\$ 75 billion): Applied Research

60% (US\$ 203 billion): Development

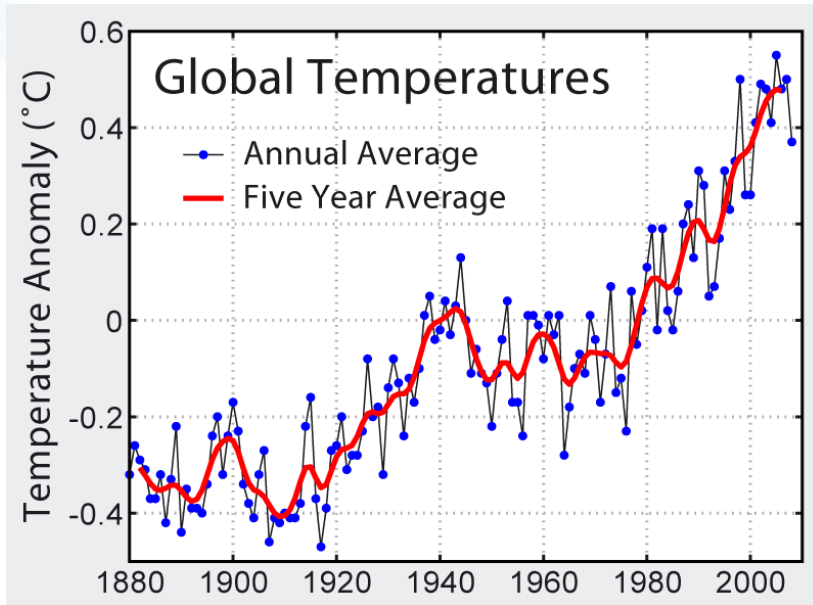
### In 2006 USA: Source of funding:

60% Federal Government

17% Industry

23% Private Foundations, Academic Institutions, Other  
Government Entities

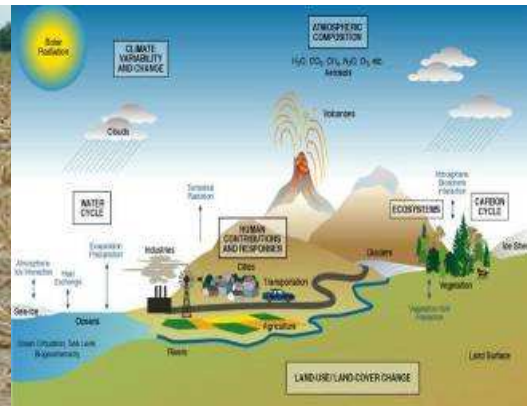
# The Climate Change



- **Global Temp rise  $0.6 \pm 0.2^{\circ}\text{C}$**
- **Av. atmospheric temp rise in Africa approx  $0.7^{\circ}\text{C}$**



- **Increased frequency of floods**



- **Increased frequency and duration of droughts**

# CLIMATE CHANGE IN AFRICA



## Models estimates

### By 2080s:

Arid and semi-arid landmasses in Africa will increase by 5-8%

### By 2090s:

Globally - The LAND AREA in DROUGHT will increase from 1% in the present day to:

- ◆ 30 % for Extreme Drought
- ◆ 40 % for Severe Drought
- ◆ 50 % for Moderate Drought

## GHGs changing due to Human Activities

↳ since pre-Industrial Era (~ 1750)

- CO<sub>2</sub> by 30%
- CH<sub>4</sub> by over 100%
- N<sub>2</sub>O by 15%

Concentrations are higher now than any time during the last 420,000 yrs

**Mass Extinction: Glaciation of Gondwana (Great Karoo) and the largest mass extinction at the end of Permian (ca. 250 Ma ago) - (85% extinction of all organisms)**



# DRASTIC GLOBAL TEMPERATURE CHANGES



- ◆ **ca. 250 Ma ago: Mass Extinction (85% of all organisms)**
  - ↳ **Glaciation of the Gondwanaland**
  
- ◆ **ca 65 Ma: Extinction of the Dinosaurs**
  - ↳ **Temperatures Changes? Asteroids & Comets (Near-Earth Objects)?**
  
- ◆ **20-30% of plant and animal species have an increased risk of extinction with projected Global Average Temperatures exceeding 1.5 – 2.5°C**

# Atmospheric Composition Change



## Natural and human induced air pollution

**Effect:** Global warming; rainfall formation; human health

**Challenges:** Long term observation & forecasts

Trans-Boundary transport

National and Regional Legal Regimes

# Nyarigagongo: 1977 & 2002



# The Complex Earth System: complex surface and sub-surface processes



# Science of Climate Change & Adaptation



## Education & Research on:

### Global Warming & its consequences

- ◆ Atmospheric temperature changes
- ◆ Rainfall Patterns (Floods & Droughts)
- ◆ Atmospheric Pollution
- ◆ Water Resources
- ◆ Water Pollution and Sanitation
- ◆ Ocean Basins and Coastlines  
(i.e., sea-level changes & ocean acidification)
- ◆ Land Degradation
- ◆ Biodiversity Loss
- ◆ Resilience for Food Systems

# NASA ACTIVITIES: Fiscal Year 2009



Budget of US\$ 20.21 billion for:

- ◆ **Science**
- ◆ **Aeronautics**
- ◆ **Exploration**
- ◆ **Education**
- ◆ **Space Operations**
- ◆ **Inspectorate**
- ◆ **Cross-Agency supporting programs**

# GLOBAL FOOD CRISIS



## Science for Global Food and Nutrition Security

- ◆ It is today estimated that **FOOD PRICES** will increase by **ca 40%**
- ◆ In the last 3 years the price of **WHEAT** has increased by **ca 180%**
- ◆ In the last 3 years the price of **RICE** has increased by **ca 77%**
- ↳ **FUTURE: Increased food production through**
  - ◆ Using less **LAND**
  - ◆ Using less **WATER**
  - ◆ Using less **CHEMICALS**
  - ◆ Using less **LABOUR** (i.e., Women & Children)



# **BIOTECHNOLOGY:**

## **How can so many genes make rice?**



**Proposed number of  
rice genes:**

***Approx 50,000***

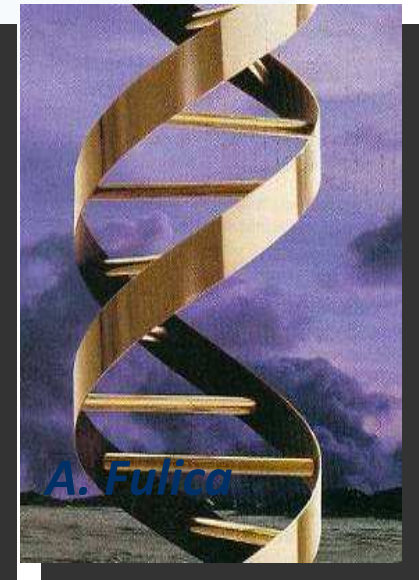
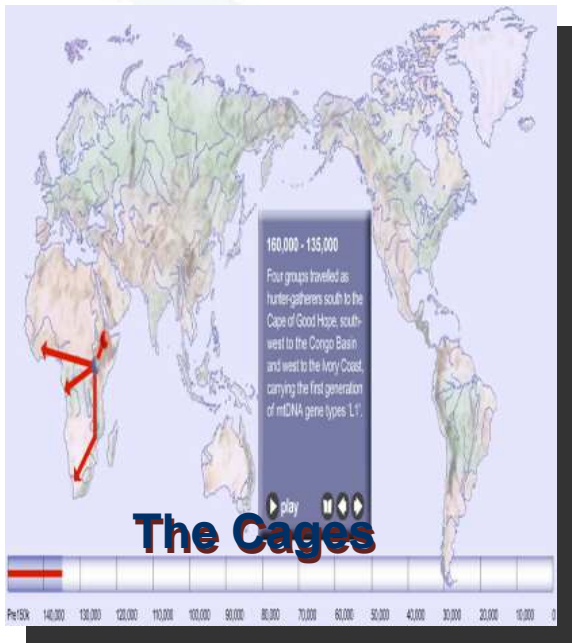


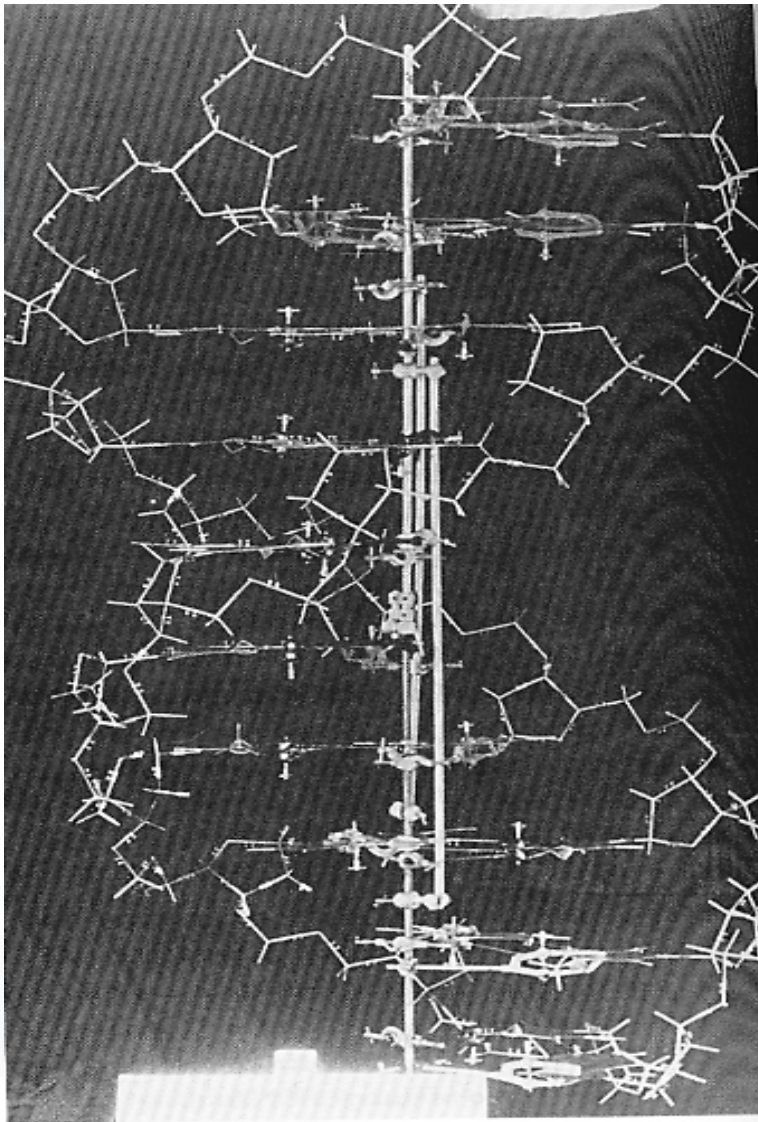
# GLOBAL FOOD CRISIS: Neglected Biota



*Termitomyces titanicus* Mushroom on a truck,  
Mshigeni, K. et al., 2008

# Edible Snails: Research in Cameroon





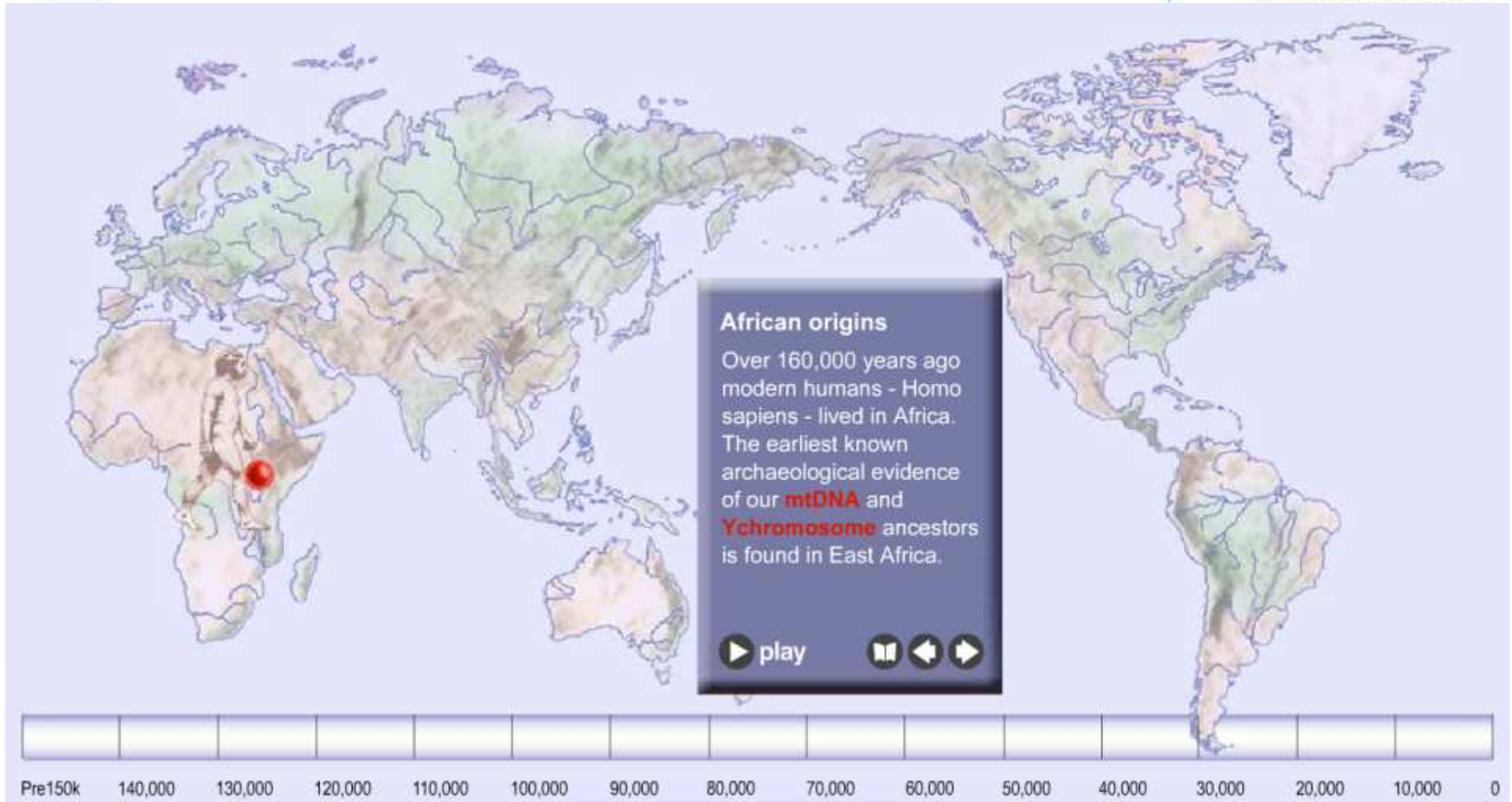
**What does DNA tell us?**

## 160,000 Years of Human Migrations

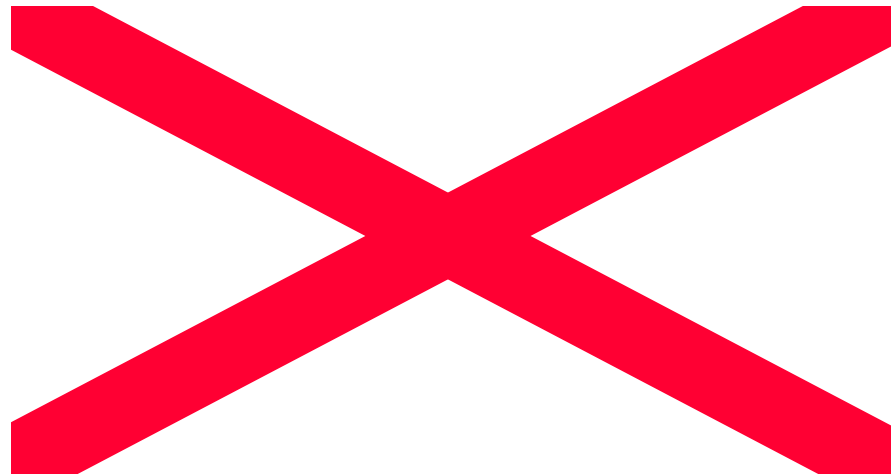


The National Geographic Society/ IBM Genographic Project 2005 – 2010  
Preliminary Results from Recent Global DNA Analysis

**Bob Citron, June 2008**



**Bob Citron, June 2008**



**Bob Citron, June 2008**

# AFRICAN HEALTH CHALLENGE

**Neglected Indigenous Knowledge System,**  
**e.g., traditional medicine (ca 70% population)**



***Sargassum* SEAWEED with medicinal properties,**  
**Mshigeni, K. et al., 2008**

# NANOTECHNOLOGY IN HEALTH SERVICE



Potential for treating diseases like **MALARIA, TB**  
**HIV/AIDS, etc**

↳ ▶ ▶ ▶ ▶ **Drug-resistant tuberculosis (XDR-TB)**

## Advantages:

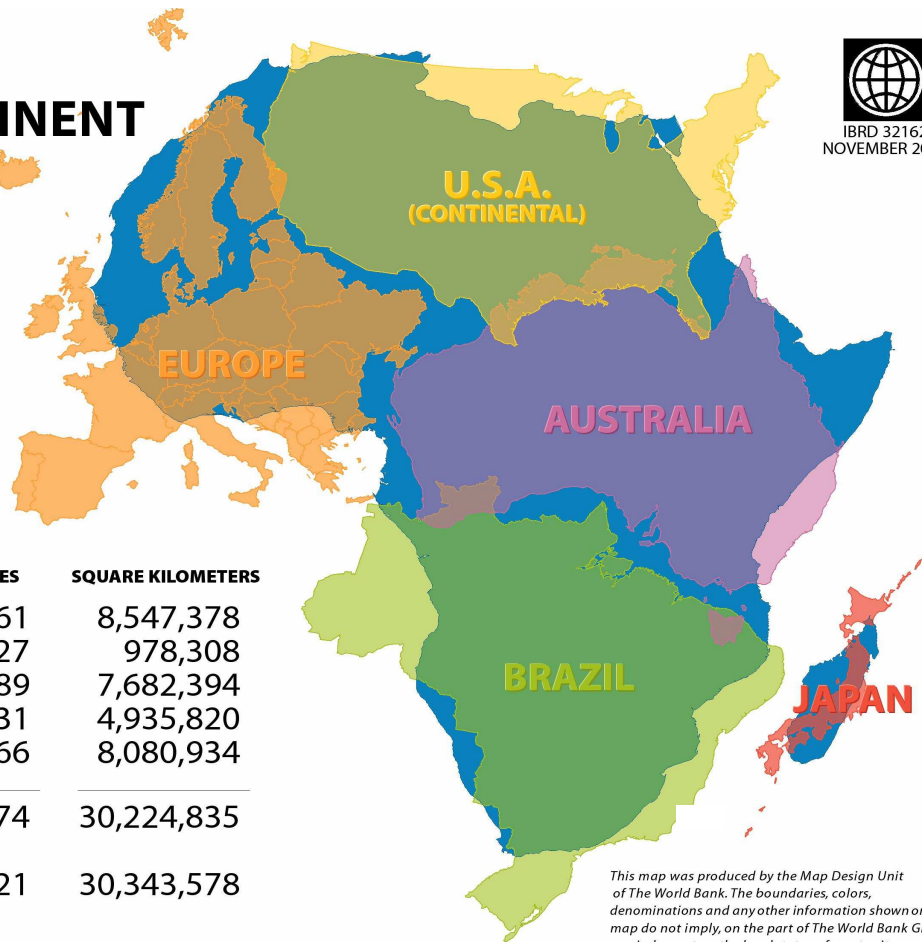
- **Cheaper medicines and vaccines**
- **Minimize the dose of drugs administered**
- **Reduce dose frequency**
- **Minimize side effects**
- **Reduce the cost of treatment**

## Estimates of Global Population 3,000 BC to 2050

Year	Population
3,000 BC	14 million
2,000 BC	27 million
1,000 BC	50 million
500 BC	100 million
<b>2008</b>	<b>6.7 billion</b>
<b>2050</b>	<b>10.0 billion</b>

# Size of Africa and its small national economies

## SIZE OF THE AFRICAN CONTINENT COMPARED TO OTHER LAND MASSES

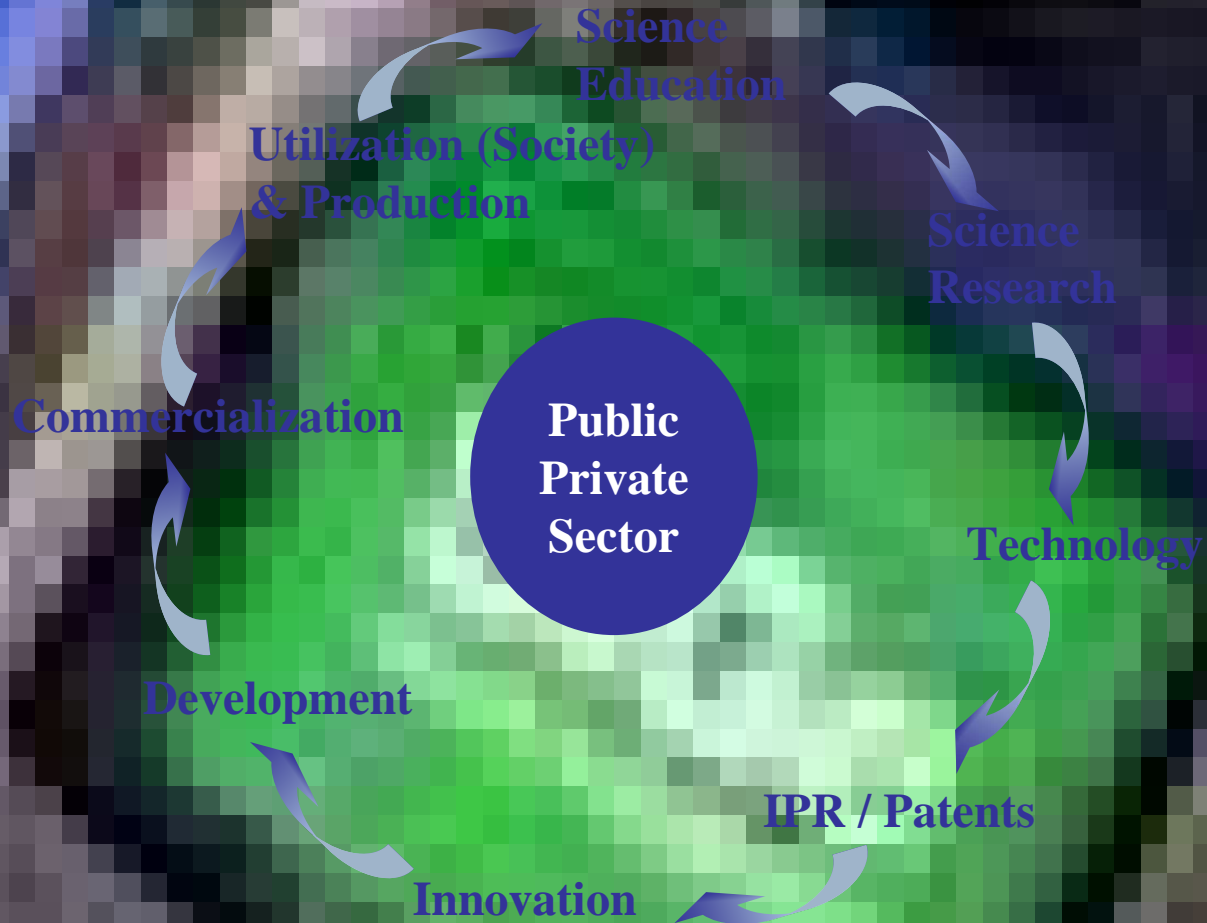


  
IBRD 32162 nce  
NOVEMBER 2002

	SQUARE MILES	SQUARE KILOMETERS
BRAZIL	3,300,161	8,547,378
JAPAN	377,727	978,308
AUSTRALIA	2,966,189	7,682,394
EUROPE	1,905,731	4,935,820
U.S.A. (Continental)	3,120,066	8,080,934
<b>TOTAL</b>	<b>11,669,874</b>	<b>30,224,835</b>
<b>AFRICA</b> (including MADAGASCAR)	<b>11,715,721</b>	<b>30,343,578</b>

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# CIRCULAR MODEL



Science Education



Research

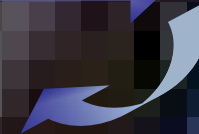


Technology



Innovation

# STRAIGHT LINE MODEL

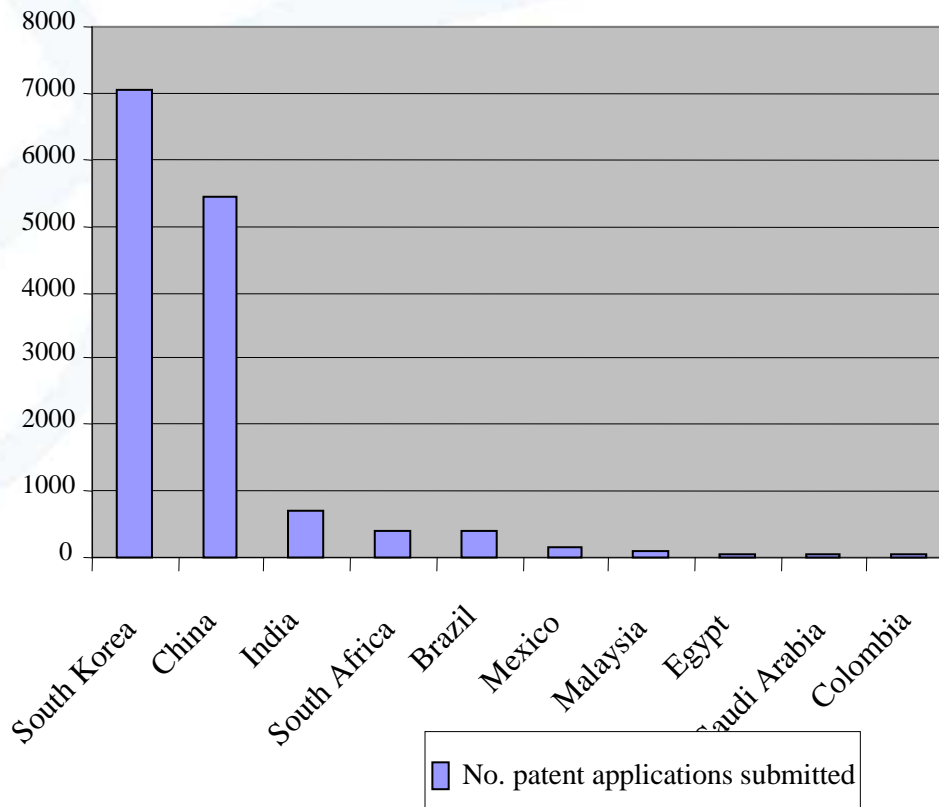


# IPR & PATENTS IN AFRICA

South Korea (7,061 applications), South Africa (390), Egypt (41)



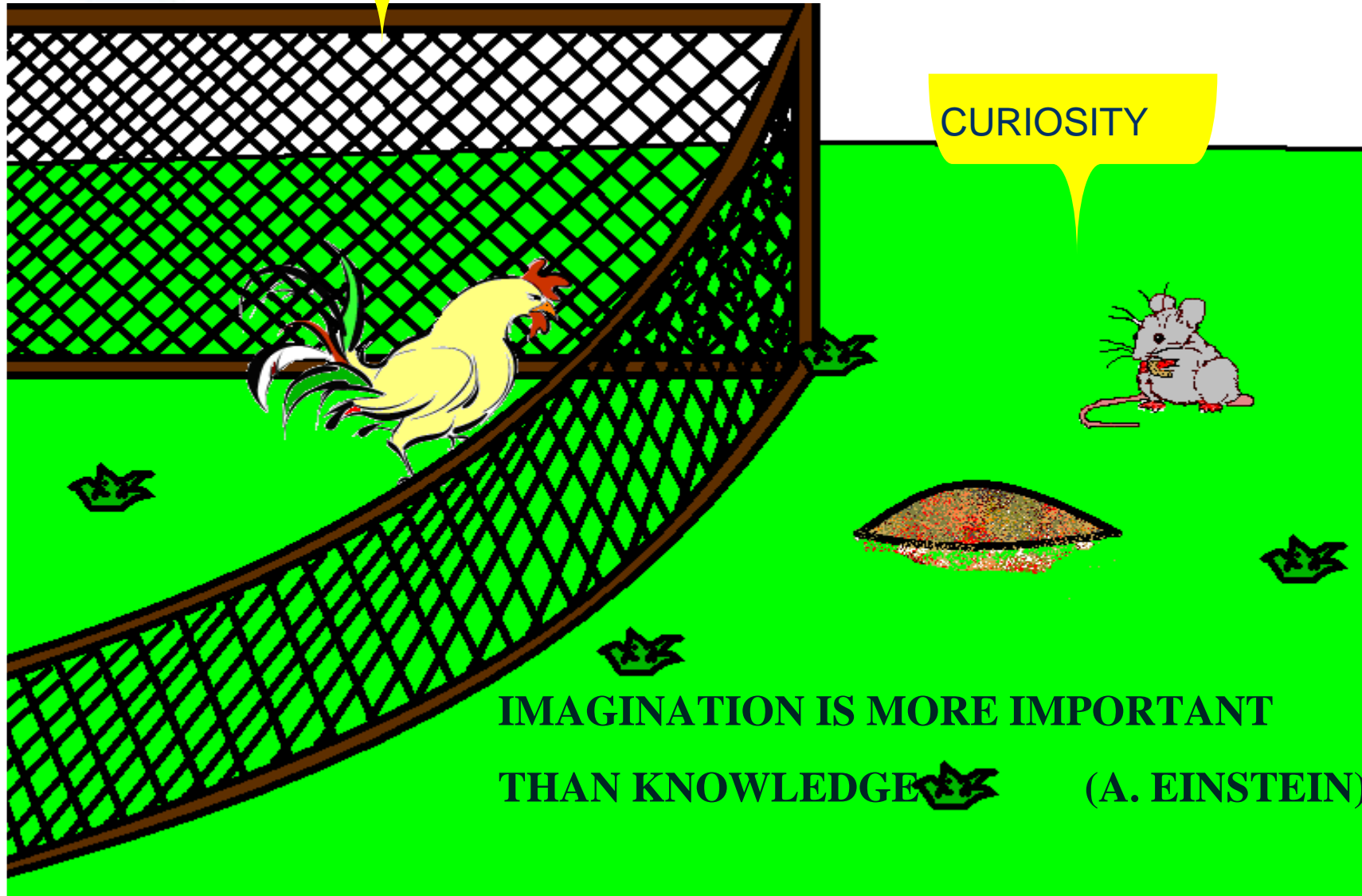
International patent applications to the WIPO from developing countries in 2007



Source: WIPO

DIRECTED RESEARCH

CURIOSITY



IMAGINATION IS MORE IMPORTANT  
THAN KNOWLEDGE (A. EINSTEIN)

# The importance of Education



## Winston Churchill (1874-1965),

British Conservative statesman and Prime Minister (1940-5 & 1951-5), had this to say,

***“the empires of the future are the empires of minds”***

Speech at Harvard, 06 September 1943.

## Jacob Bronowski (1908-1974),

A Polish-born mathematician and humanist, told us the following,

***“the aim of science is not to open the door to infinite wisdom, but to set a limit to infinite error”***

# Science in Service of Society



**Mwalimu Nyerere:**

**“We must run while they are walking”**

**“It can be done, play your part”**

**“Privilege to get Education....  
Starving village.....  
Traitor”**

***Thank you for your attention***