STEM EDUCATION: OBSERVATIONS AND RECOMMENDATIONS

A Keynote Address

at the

55th ANNUAL CONFERENCE

of the

SCIENCE TEACHERS ASSOCIATION OF NIGERIA (STAN)

ASABA, DELTA STATE, NIGERIA

by

Prof. Hilary I. Inyang

Vice Chancellor and Distinguished Professor

Botswana International University of Science and Technology

Palapye, Botswana

August 18 - 23, 2014

STEM STUDENTS IN SECONDARY AND TERTIARY INSTITUTIONS SHOULD KNOW THE CONTEXT OF THEIR TECHNICAL EDUCATION

- Supply of options for sustainable development
- Production of data for decision support systems
- Development of human resources and capacity
- Creation of innovative ideas and products
- Guardians of rationality and human rights

HISTORY ALWAYS PROVIDES CONTEXT IN ANCIENT AFRICA

- The ancient city of Meroe (1000 miles south of Khartoum) dates back to 2000 and exhibits advances in iron technology that lasted until A.D.300.
- The Mali Empire cities of Timbuktu and Djenne were great centers of scientific thought in the 1300s.
- The Egyptian surgical papyrus which is shelved in the New York Academy of Medicine was the first medical textbook. It dates back to 4000 B.C.
- As late as 1879, R.W. Felkin, a Scottish Medical missionary witnessed surgery performed by Africans in Uganda

IN MORE RECENT TIMES

- Africans and African Americans did excel to the extent that slavery and discrimination allowed:
- In the 1800's, Benjamin Banneker, a black mathematician made the first American clock.
- In 1872, Elijah McCoy invented the automatic lubrication system for machines. He held patents for 50 additional inventions.
- Lewis Latimer (1848-1928) invented the light bulb and supervised the installation of electric lighting systems in New York, Philadelphia and Montreal

IN MORE RECENT TIMES (CONT'D)

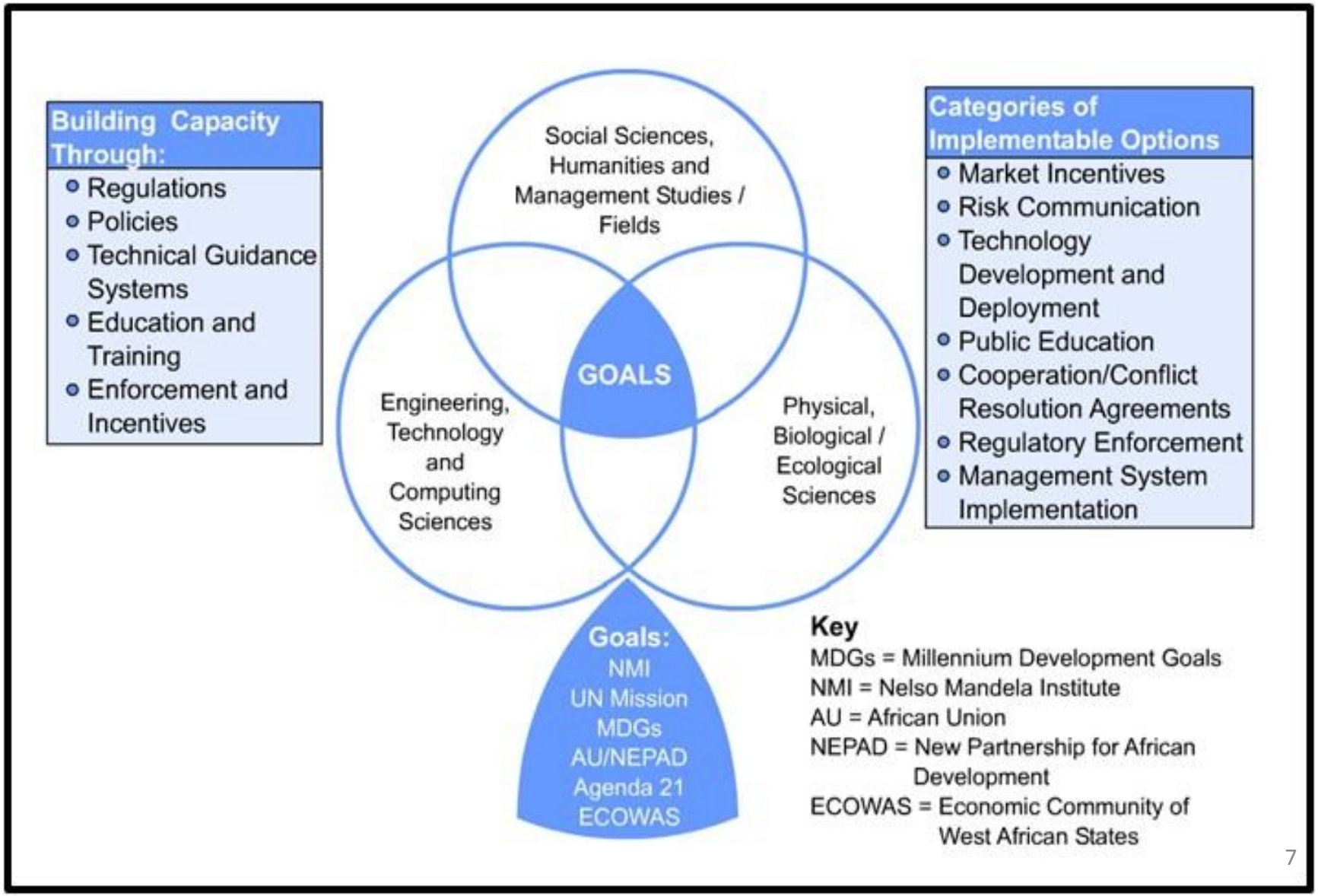
- George Washington Carver graduated from Iowa State University in 1894. When he died in 1943, he left behind more than 300 patents, including

- Face powder
- Pigments for paints
- Soap
- Synthetic marble

TRACKING PROMISING ECONOMIC SECTORS FOR STEM CAREER CHOICES

SECTOR OR SUB-SECTOR	WARRANT
1.AGRICULTURE	•Food crisis that requires increases in production •Availability of Subsidies
2. RENEWABLE ENERGY	•Climate change concerns •Need to supply technicians and maintenance systems •Increase in loan prospects
3. INTELLECTUAL PROPERTY LAW	•Growth of the film/music industry •Increasing number of tertiary institutions
4. PROPERT/INFRASTRUTURE MANAGEMENT AND MAINTENANCE	•Housing demand/investments •Importation of high-tech equipment •Increasing foreign/domestic investments
5.POLITICAL POLLING	•Insatiable interest of Nigerians in politics •Lack of dependable data for use in strategising
6. COMMUNITY HEALTH	•Emergence of national health management and insurance systems •Interest of international/national agencies
7. ACADEMIC ADVISING, TEACHING AND HUMAN RESOURCES MANAGEMENT	•Growing number of schools at all levels •Perennial lack of trained academic personnel
8. INFORMATION MANAGEMENT SYSTEMS	•Aging of physical data files •Evolution of large data banks

THE THREE RINGS OF DISCIPLINES THAT SUPPORT OPTIONS ON SUSTAINABLE DEVELOPMENT .



TERTIARY EDUCATIONAL PROGRAMMES NEEDS TO TAKE COGNIZANCE OF OPPORTUNITIES IN VARIOUS ECONOMIC SECTORS IN AFRICA THE CASE OF BOTSWANA

RECENT (2013) PROJECT INVESTMENTS IN VARIOUS ECONOMIC SECTORS

ALIGNMENTS OF BIUST ACADEMIC AND RESEARCH CONFIGURATIONSARE INDICATED

BIUST

- Centr. for Entrep.
- Centr. for Manuf. Systems and Robotics

BIUST

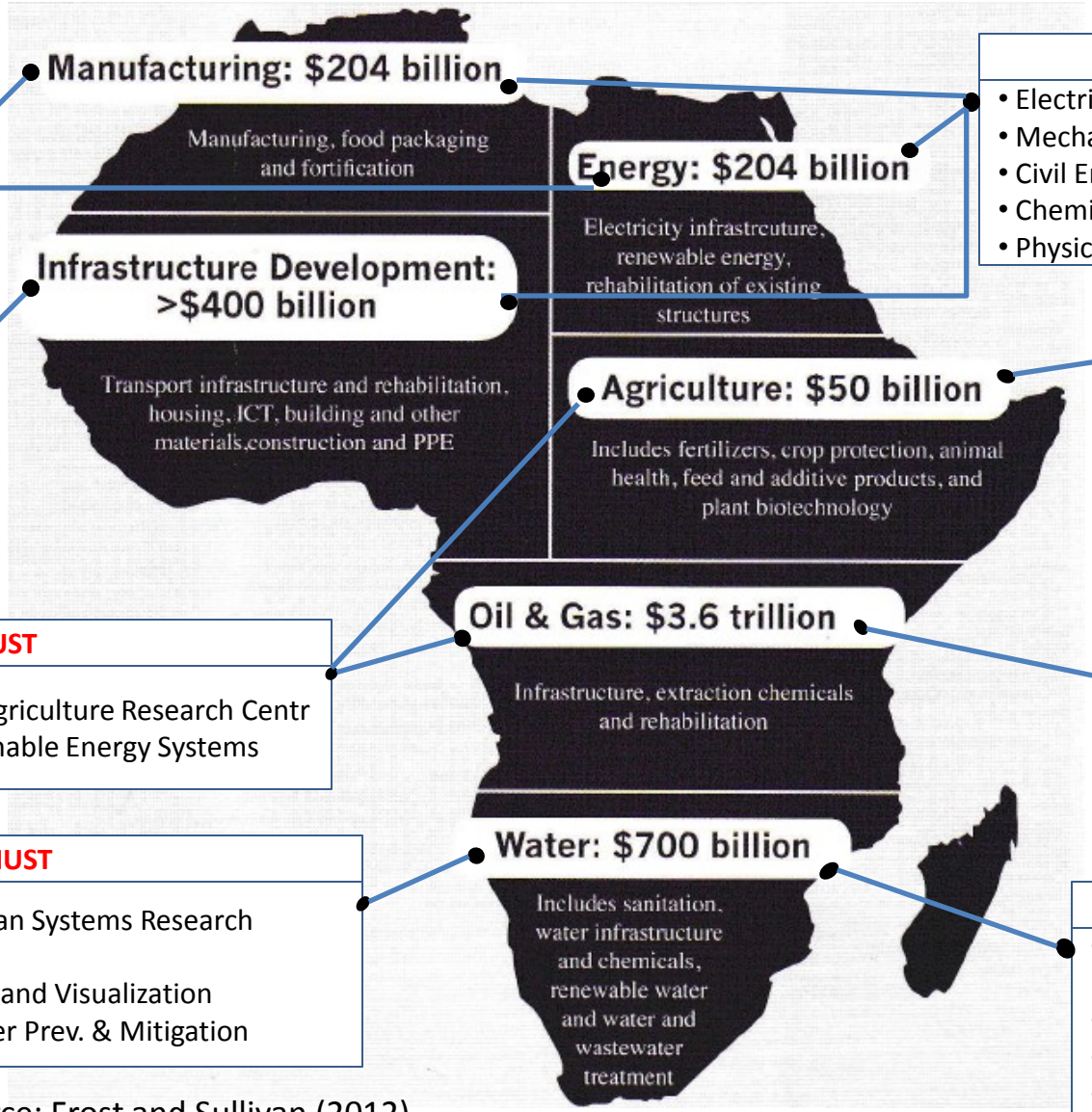
- Centr. for Innovation in Mining Systems
- Centr. for Infrastr. Dev. and Maintain.
- Construct Mat. Tech Centr

BIUST

- Biotech. And Tropical Agriculture Research Centr
- Global Centr. for Sustainable Energy Systems

BIUST

- Environmental and Urban Systems Research Institute
- Centr. for Data Analysis and Visualization
- African Centr. for Disaster Prev. & Mitigation



BIUST

- Electrical Engineering
- Mechanical Engineering
- Civil Engineering
- Chemical Engineering
- Physical & Biological Sciences

BIUST

- Agriculture
- Biological Sciences
- Mechanical Engineering

BIUST

- Chemical Engineering
- Geological Engineering
- Chemistry
- Earth Sciences

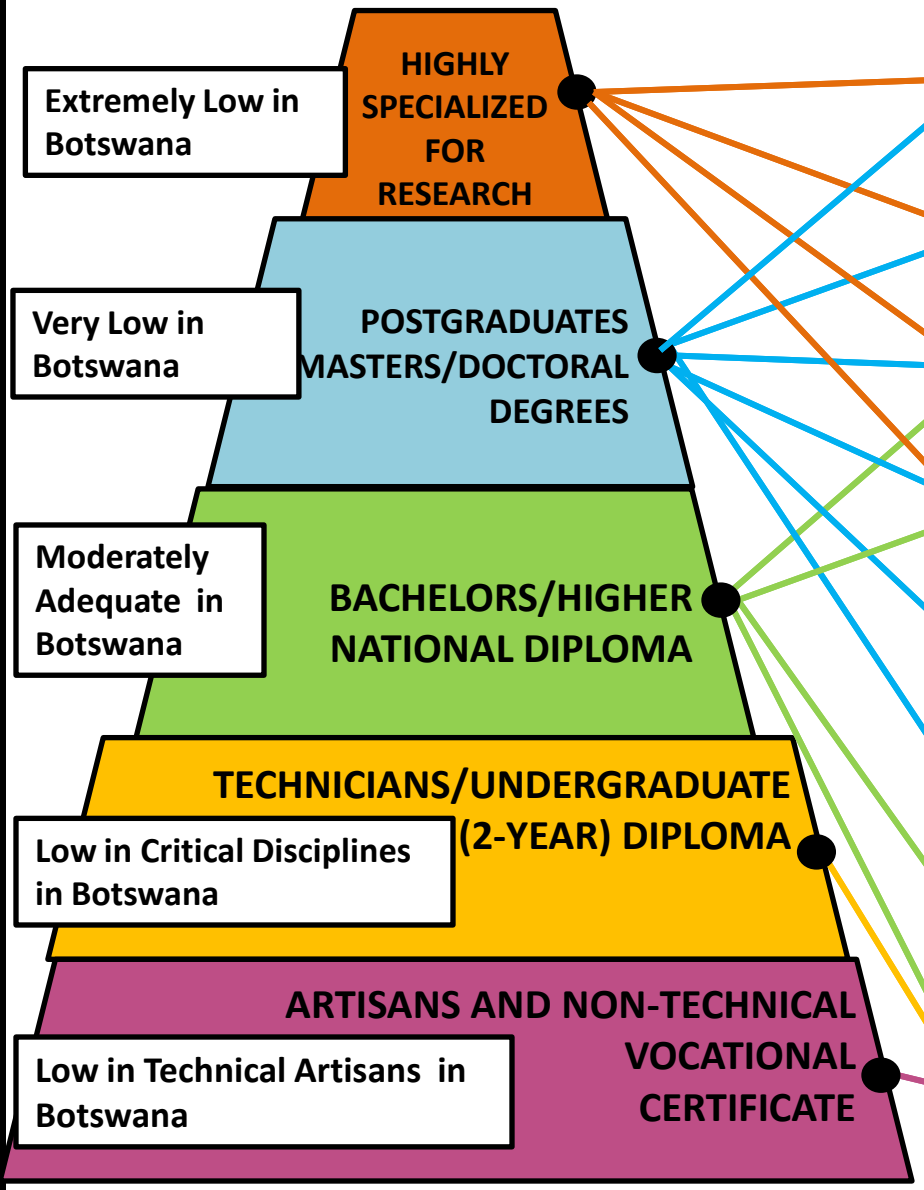
BIUST

- Civil & Environmental Engineering
- Physical Sciences
- Environ. Sciences
- Environ. Management

Source: Frost and Sullivan (2012)

NECESSARY DISTRIBUTION OF GRADUATES AT VARIOUS EDUCATIONAL ATTAINMENT LEVELS TO SUPPORT ECONOMIC DIVERSIFICATION DRIVE (EDD) THE CASE OF BOTSWANA

QUALIFICATIONS HIERARCHY



NECESSARY DEVELOPMENTS IN BOTSWANA

- Reduce Waiting /Processing Periods for Critical Foreign Personnel at Department of Labour to Support National Initiatives and Projects
- Creation of a Botswana Extramural Research Grants Programme on Key National Issues
- Evolution of Botswana Innovation Hubs to Support Advanced Research in Botswana
- Increase in Collaborative Research Centers and Incubation Parks in Botswana's Universities
- Operation of Thesis Writing Camp to Support Completion of Post-Graduate Degrees by Candidate
- Operation of In-Service/Part-Time/Distance Postgraduate Programmes for Regular Employees
- Transfer of Successful Graduates of 2-Year Colleges to 4-Year Degree Programmes in Universities
- Increase in Small and Medium-Scale Businesses (SMEs) with Funding from Financial Institutions to Expand Opportunities for Artisans and Others

CATALOGUE OF ARTISAN-LEVEL AND TECHNICIAN-LEVEL SKILLS THAT ARE NECESSARY TO SUPPORT BOTSWANA'S SOCIO-ECONOMIC DEVELOPMENT NEEDS IN THE 21ST CENTURY

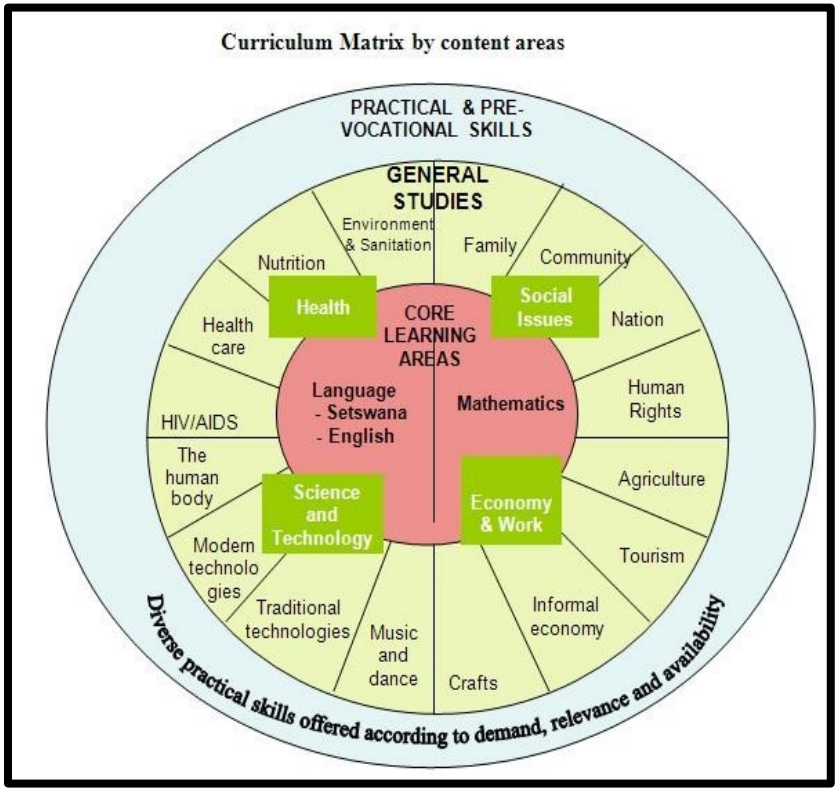
- Waste management operations
- Weaving
- Landscaping
- Interior Design
- Shoemaking/repair
- Printing technology
- Paper mill operations
- Waste treatment technology
- Water drilling operations
- Plumbing technology
- Air conditioning assembly and repair
- Refrigerator assembly and repair
- Plastic molding
- Truck driving and construction equipment operation
- Television and telecommunication equipment assembly and repair
- Instrumented carpentry
- Metal works and welding
- Computer hardware assembly and repair
- Secretarial service
- Airport logistics
- Road construction and repair
- Urban drainage technology
- Hospitality/tourism
- Emergency management and road safety
- Security/surveillance techniques for public safety
- Food processing and storage
- Farming techniques
- Large-scale tailoring
- Community health inspection
- Photography/filming operations
- Tank/pipeline/cable installation
- Building/bricklaying operations
- Fish farming
- Quarry operations
- Pottery

FEEDER PROGRAMMES (PRIMARY AND SECONDARY) INTO TERTIARY INSTITUTIONS MUST HAVE REGULAR AND REMEDIAL PROGRAMMES TO PREPARE INCOMING STUDENTS APPROPRIATELY

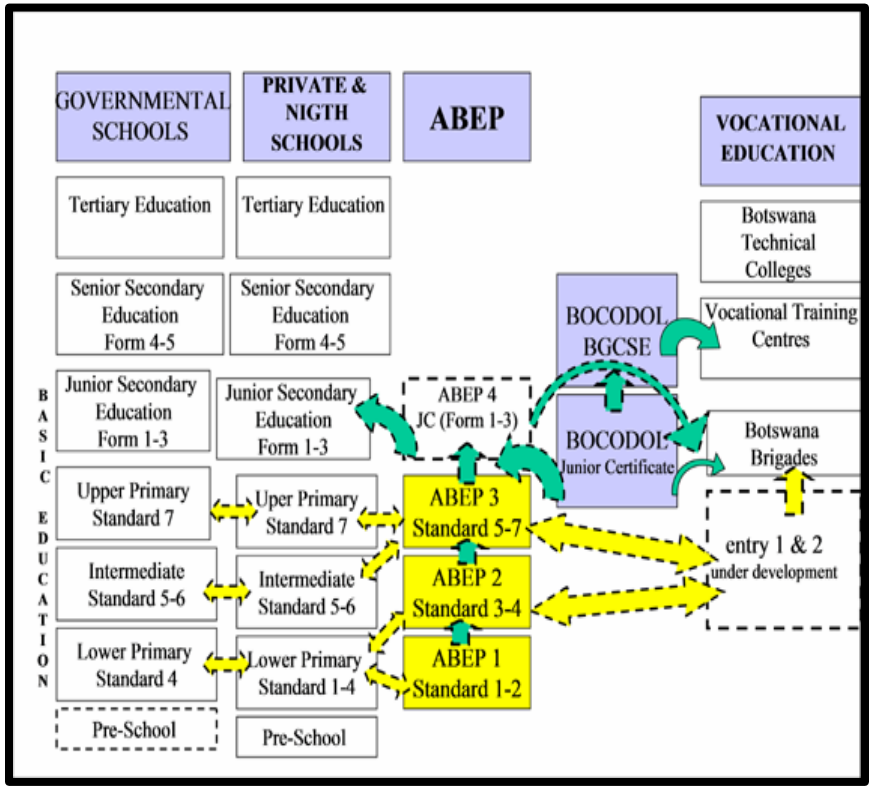
THE BOTSWANA EDUCATIONAL SYSTEM

INCREASE BOARDING IN BOTSWANA'S SECONDARY SCHOOLS TO MAXIMIZE OFF-TEACHING STUDY TIMES

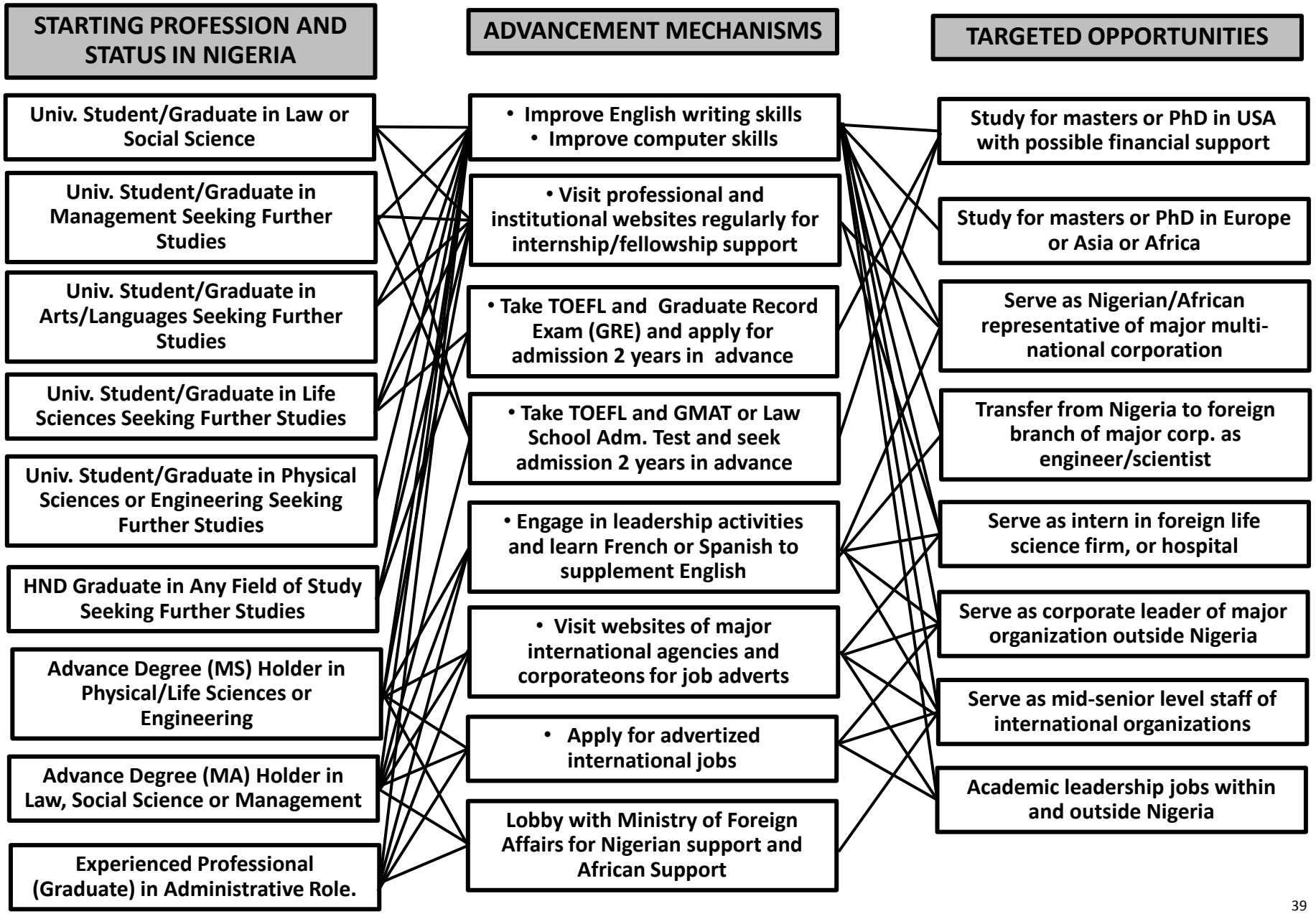
The Botswana Adult Basic Education Program (ABEP)



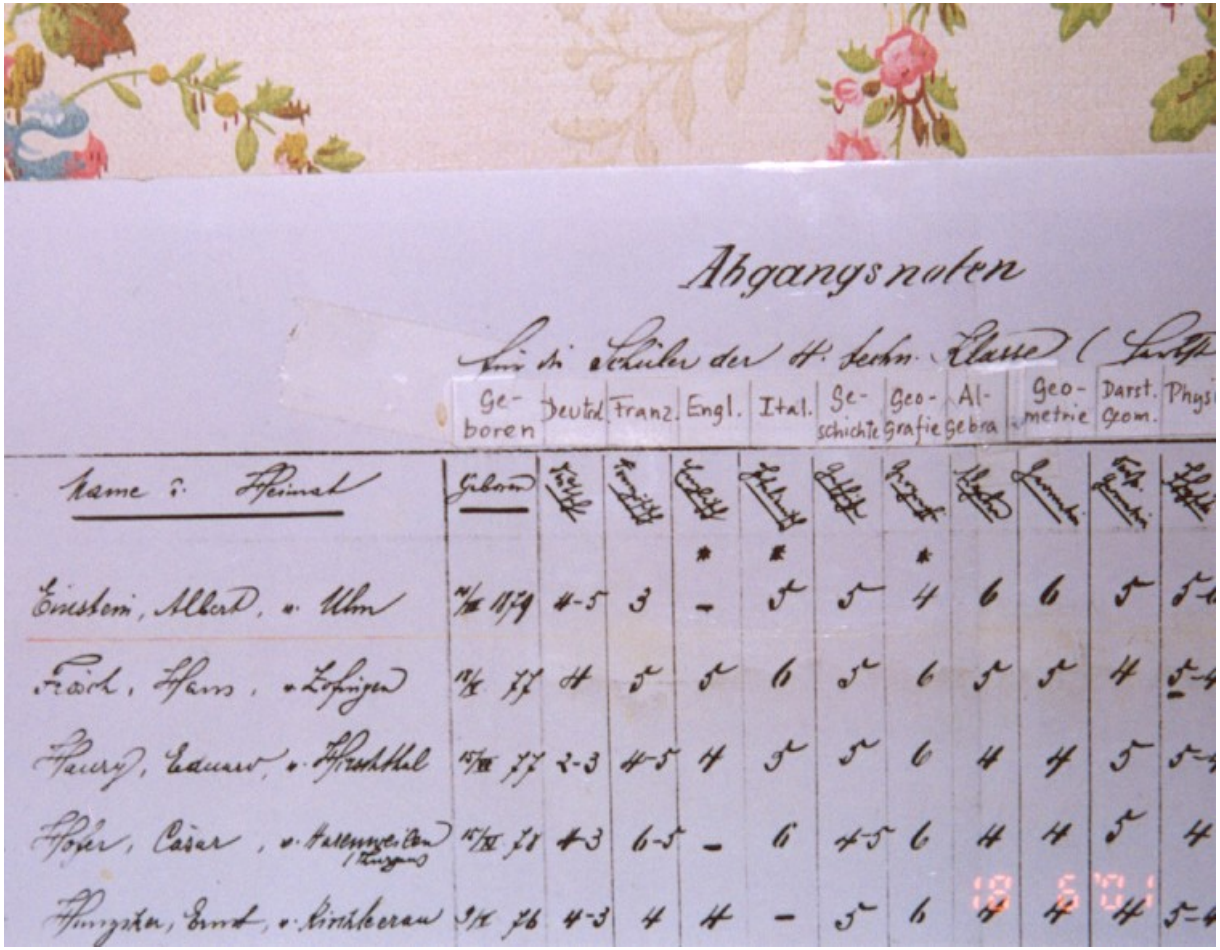
Education level interactions in Botswana (Source: UNESCO)



PATHWAY TO PROFESSIONAL LEADERSHIP IN VARIOUS SETTINGS



WHO SAYS EINSTEIN HAD A CULTURE OF THINKING LIKE HIS TEACHERS OR EVEN CARED ABOUT LANGUAGES?



Abgangsnoten

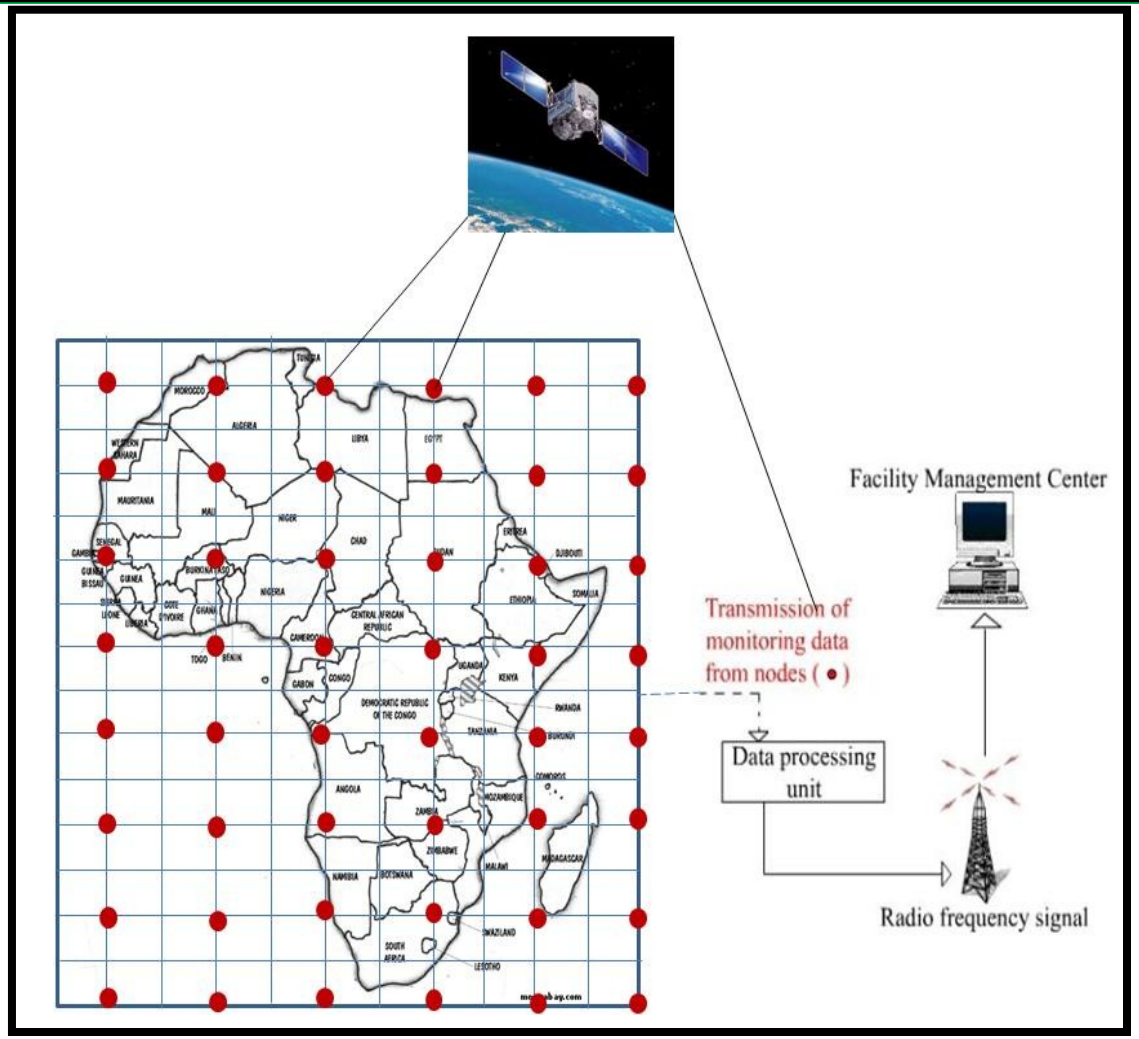
Name u. Heimat	Geboren	Deutsch	Franz.	Engl.	Ital.	Geschichte	Geografie	Algebra	Geometrie	Darst. Geom.	Phys
				*	*		*				
Einstein, Albert, v. Ulm	14/3 79	4-5	3	–	5	5	4	6	6	5	5
Reich, Hans, v. Lobsigen	11/4 77	4	5	5	6	5	6	5	5	4	5
Haury, Eduard, v. Hirschthal	15/8 77	2-3	4-5	4	5	5	6	4	4	5	5
Hofer, Cäsar, v. Fallenzweiten (Thurgau)	15/8 78	4-3	6-5	–	6	4-5	6	4	4	5	4
Hunziker, Ernst, v. Kirchberg	9/8 76	4-3	4	4	–	5	6	4	4	4	5

I took this picture of the grade book of Albert Einstein's class when I attended a reception for the US AAAS Delegation in Einstein's Family house in Bern, Switzerland hosted by members of the Swiss Parliament on June 18, 2001

STUDENTS IN SCIENCE AND TECHNOLOGY NEED TO HAVE INFORMATION ON FUTURE CAREER PLAYERS

CATEGORIES	EXAMPLES	APPROACH(ES)
INTERNATIONAL AGENCIES (UN)	• United Nations (Agencies) e.g • UNIDO (industrial) • UNEP (environment) • UNDP (development) • UNESCO (education, science, culture) • Peacekeeping operations • Several others	• Monitor UN (global) employment website monthly • Complete the employment profile form and keep for quick responses • Monitoring country office advertisements
INTERNATIONAL AGENCIES (Foundations)	• United Nations (Agencies) e.g • UNIDO (industrial) • UNEP (environment) • UNDP (development) • UNESCO (education, science, culture) • Peacekeeping operations • Several others	• Monitor UN (global) employment website monthly • Complete the employment profile from and keep for quick responses • Monitoring country office advertisements
MAJOR CORPORAIONS	• Multi-Nationals (incoming) • Chinese Firms • Telecom Firms • Biotech and Pharma Firms • Agric and Energy Firms	• Get info from Ministry of Commerce about incoming firms • Research into their products and services • Propose critical service and/or sub-contract • Seek a physical meeting • Volunteer self as local employment at appropriate level
GENERATION EMPLOYEES	• Other African Countries With Need for Qualified Workers • South Africa • Namibia • Botswana • Gambiia • Sierra Leone	• Read the *ECONOMIST* and papers from other countries • Target countries e.g in Africa with improving economies, e.g SA, Angola, Gambia, Gabon, Botswana • Review language and Culture • Solicit with employment agencies

EXISTING DATA THAT ARE GIVEN VARIOUS SPATIO-TEMPORAL COORDINATES NEED TO BE INTERLINKED WITH MORE RECENT DATA THAT CAN BE GENERATED BY SATELLITES AND TRANSFERRED BY BOTH SATELLITE AND CABLE COMMUNICATION SYSTEMS

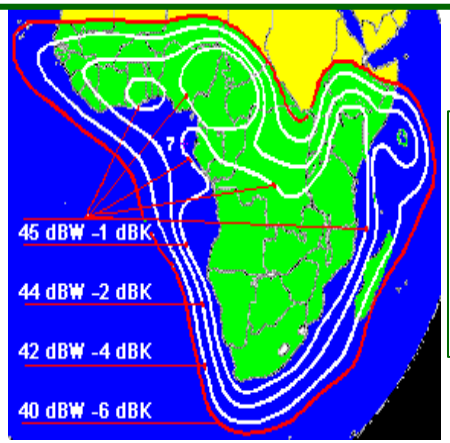


EXAMPLES OF DATA/INFORMATION COMMUNICATION SATELLITES WITH SIGNIFICANT FOCUS ON AFRICA THAT SHOULD EXCITE STEM STUDENTS

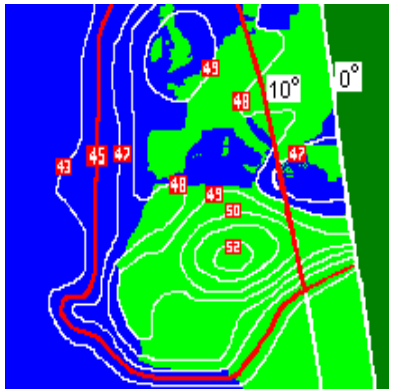
BENTLEY TELECOM EUTELSAT W3A

Bentley Telecom Eutelsat W3A

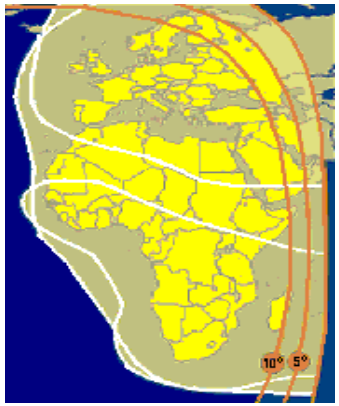
Eutelsat W3A (7 deg east) broadband internet via satellite coverage using **the new Hughes HX** and LinkStar DVB-S2 and iDirect technologies. The Hughes HX, introduced in March 2008, represents a significant step forwards. Various grades of service plus special quality of service controls and advanced proprietary TCP/IP compression to give faster downloads compared with unprocessed feeds, plus customer access to traffic monitoring system.
Click here to email: **sales@bentleywalker.com** or phone now 00 44 239 246 3943 (ref:satsig)
Also iDirect STAR COM service in North East Africa



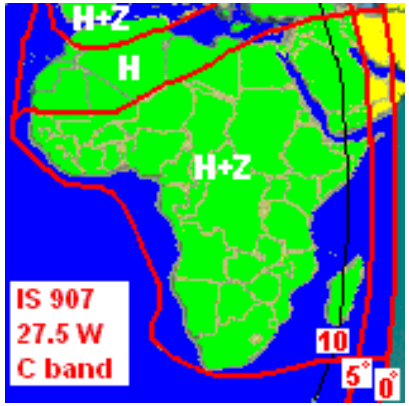
Mid Africa and South Africa coverage Direct connection provider.



Customer VSAT dishes are typically 1.2m diameter with up to 61 PCs connected

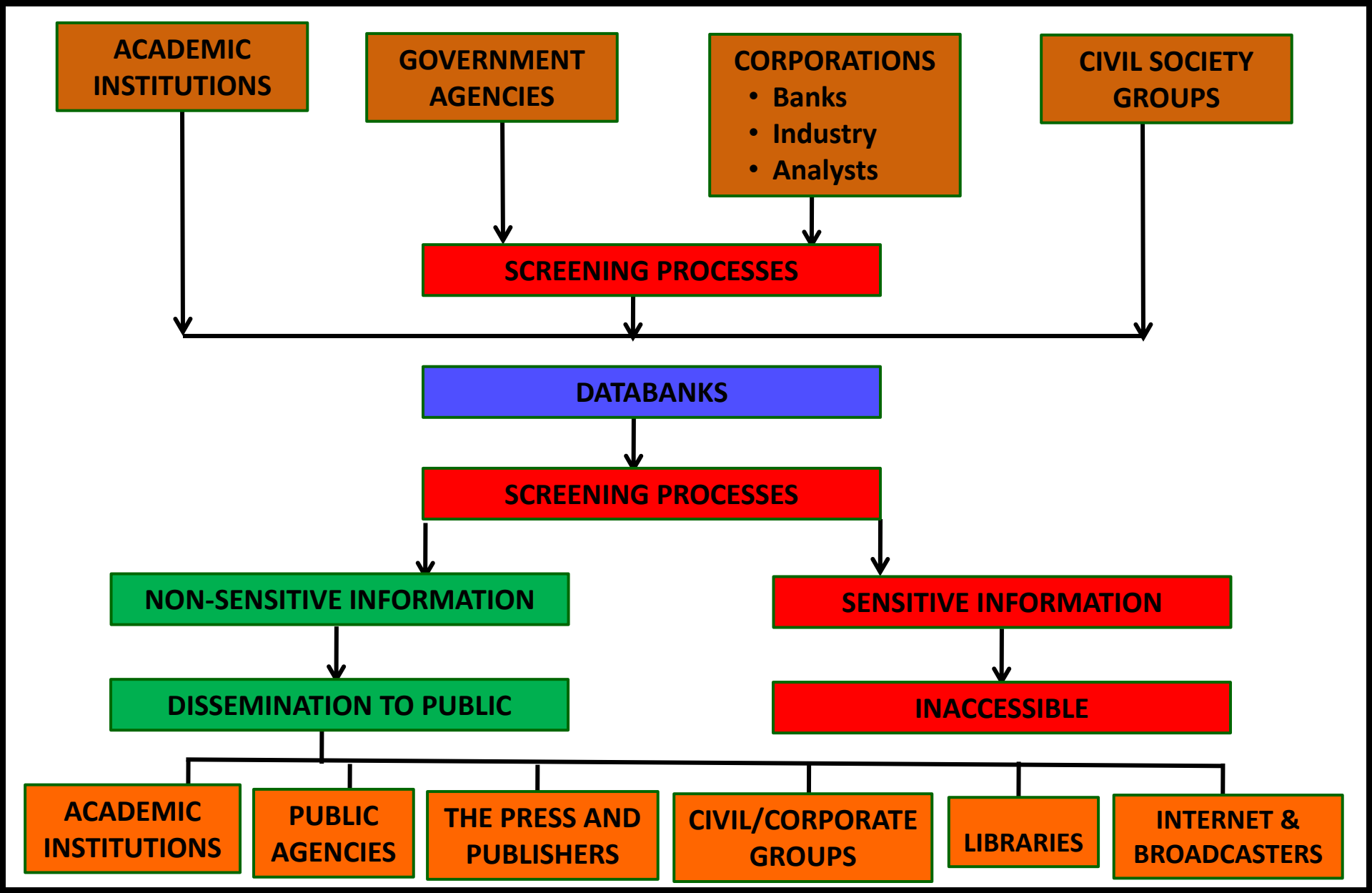


All Africa, Middle East and Europe.
C band on 1.8m dish



PanAmSat 1R at 45 west is also available and provides good coverage of North West Africa.

STEM PROGRAMMES SHOULD TAKE ADVANTAGE OF INFORMATION MANAGEMENT SYSTEMS CONFIGURATION OF INFORMATION GENERATION, STORAGE AND ACCESS SYSTEMS



CONCLUSIONS

- **Without opportunities, talent is latent**
- **Individuals also have to posture as follows to capitalize on opportunities that may be created**
    - **Education/Enlightenment**
    - **Capacity to navigate across cultures**
    - **High moral values.**

NO CONDITION IS PERMANENT

JUST DON'T ASK

Thank you

Prof. Hilary I. Inyang

Vice Chancellor, Botswana International University of Science and technology (BIUST),
Palapye, Botswana; and Member, Education Caucus, United Nations Commission on Sustainable Development (UNCSD)

Email: h.inyang26@gmail.com , Tel: Cell (Botswana) +267-76066428, +267-75473445

Prof. Inyang is currently the Vice Chancellor, Botswana International University of Science and technology (BIUST), Palapye and served from 2001 to 2013 as the Duke Energy Distinguished Professor of Environmental Engineering and Science, University of North Carolina, Charlotte, USA; Prof. Inyang has made more than two decades of technical and policy contributions to regional and global sustainable development as an educator/administrator, researcher, government official and corporate leader. He is a former President of the African University of Science and Technology, Abuja, Nigeria and Founding Director of the Global Institute for Energy and Environmental Systems (GIEES) at the University of North Carolina-Charlotte. In 2008, he was a finalist for the position of United Nations Under Secretary-General and Rector of United Nations University in Tokyo. He was the President of the International Society for Environmental Geotechnology (ISEG) and leads the Global Alliance for Disaster Reduction (GADR). In 2008, he was selected as a Technical Judge of the US Nuclear Regulatory Commission. From 1997 to 2001, he was the Chair of the Environmental Engineering Committee of the United States Environmental Protection Agency's Science Advisory Board, and also served on the Effluent Guidelines Committee of the National Council for Environmental Policy and Technology. Prior to his position at the University of North Carolina-Charlotte, he was DuPont Professor/University Distinguished Professor at the University of Massachusetts, where he helped establish the Graduate School of Marine Science and Technology of the University System, while serving as the Founding Director of the Lowell-based Center for Environmental Engineering, Science and Technology (1995 - 2000). He taught previously at Purdue University, George Washington University and the University of Wisconsin-Platteville where he started his academic career 22 years ago. He has helped establish research institutes and operate educational programs in Brazil, Japan, Korea, India, Canada, Nigeria, Ghana, United Arab Emirates and China at where he has been an Honorary Professor/Concurrent Professor (CUMT and Nanjing University) since 2004 and 1999, respectively.

Prof. Hilary was the first black person to be endowed as a distinguished professor in environmental engineering in the United States, as well as the first African immigrant to Chair a Committee of the congressionally mandated national science advisory body of a US agency. During his career in academe, the private sector and government, he has developed innovative materials, systems (including GEORAD Barrier Concept) and performance estimation tools for long-term (100-10,000 years) containment of contaminants and suppression of dust to reduce environmental and health risks in climatic zones, ranging from the hot/humid tropic to the frigid Arctic. He has led/performed research expeditions to Jiangsu Province of China on mining subsidence and erosion; Siberia (Russia) on oil spills; Niger Delta of Nigeria on oil spills; Alaska on Permafrost degradation due to global climate change; and Minas Gerais region of Brazil on fugitive dust emission studies. Hilary is a prolific developer of analytical frameworks, quantitative models and field-relevant data that have been used by agencies, researchers, private firms and students worldwide. He pioneered the incorporation of fundamental chemo dynamic mechanisms into contaminant leachability models for estimating emission source terms for materials under scenarios in which they are subjected to both load and environmental stresses. His models and experimental data on physic-chemical interactions between natural/synthetic polymers and lateritic soils have provided rational bases for aqueous polymer application in dust control to safeguard human health in many countries. Among the several national and international environmental and economic development programmes that he has contributed to are the Nigerian Governments' programmes on oil spills management; environmental hazards control in Africa; science and technology development in Africa; and research support.

He has authored/co-authored more than 260 research articles, book chapters, federal design manuals and the textbook, *Geoenvironmental Engineering: principles and applications*, published by Marcel Dekker (ISBN: 0-8247-0045-7). His research and professional focus are on contaminant leaching and dusting from materials, containment systems and materials for barriers, energy systems and geohazards. He was the Editor-in-Chief of the *Journal of Energy Engineering* of the American Society of Civil Engineers (ASCE), an associate editor/editorial board member of 27 refereed international journals and contributing editor of three books, including the United Nations Encyclopedia of Life Support Systems (Environmental Monitoring Section). Professor Inyang has served on more than 100 technical and policy panels of governments and professional societies, and has given more than 130 invited speeches and presentations on a variety of technical and policy issues at many institutions and agencies in several countries, including the Goldberg-Zoino Lecture at MIT (1994), the AMOCO Foundation Lecture at Iowa State university (1996), the ALCOA Endowed Lecture at Carnegie-Mellon University (2002), and addresses at the Parliament of Switzerland in Bern (2001) and Nigerian Senate Environmental Committee (2008). He has chaired/co-chaired international conferences in Korea, Japan, Turkey, the United States, Brazil, Finland, Canada, Slovenia, Ghana, China and Nigeria. Professor Inyang holds a Ph.D. with a double major in Geotechnical Engineering and Materials, and a minor in Mineral Resources from Iowa State University, Ames, Iowa; an M.S. and B.S. in Civil Engineering from North Dakota State University, Fargo, North Dakota; and a B.Sc. (Honors) in Geology from the University of Calabar, Nigeria.

He has served as principal investigator, co-principal investigator and implementation leader on 40 projects. His research has been sponsored by NOAA, FHWA, USDOE, USDOD, USNRC, DuPont Corporation, Sandia National Laboratory, Duke Energy Corporation and the National Science Foundation. For his research contributions to advances in geoenvironmental science and engineering, professional practice in many countries, and public policies on energy and environmental issues, he has received several professional honors, including selection as a Fellow of the Geological Society of London, the 1999 Chancellor's Medal for Distinguished Public Service of the University of Massachusetts, Lowell; 2001 Swiss Forum Fellow selection by the American Association for the Advancement of Science ; the 1996 US National Research Council Young Investigator Selection; 1992 Eisenhower-Jennings Randolph Award of the International Public Works Federation/World Affairs Institute that was instituted to honor the international achievements of former U.S. President Dwight D. Eisenhower; the 1991 American Association for the Advancement of Science/USEPA Environmental Science and Engineering Fellowship; and election (by eminence) as a Board-Certified Member (BCEEM) of the American Academy of Environmental Engineers (2006). On October 2, 2002, he was honored in Washington, DC at a ceremony organized by the US Government to honor 10 environmental scientists for technical contributions to the United States through the USEPA.