IAEA
International Atomic Energy Agency
Atoms for Peace and Development

The need for radiotherapy in low and middle income countries: the IAEA perspective

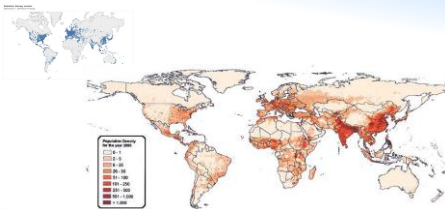**Debbie van der Merwe and Eduardo Zubizarreta**
AAPM Annual Meeting 2019

DIRAC https://dirac.iaea.org/

Radiation therapy centers

Population density

http://www.fao.org/3/a0310e/A0310E06.htm

Arable land

https://gisgeography.com/agriculture-maps-global-farming/

Arable land (FAO)
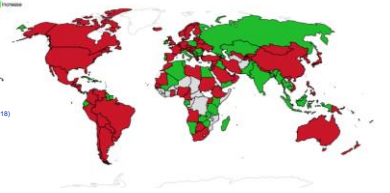

https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?view=map

6-10 years: CAPACITY AND COVERAGE Polo, et. al. ESTRO 2019

INSTALLED CAPACITY BY REGION (MV per million and MV per 1000 cancer cases)

MV units/MillionPop (2008 - 2018)
- Increased in 109 countries
- Decreased in 31 countries
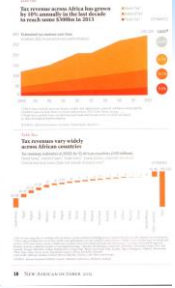
MV units/1000CaCases (2012 - 2018)
- Increased in 52 countries
- Decreased in 84 countries

	Africa	Asia	Europe	LAC	NA	Oceania
Median (mean) variation (%) in MV units per million (2008-2018)	0 (19.25)	28.87 (52.65)	31.05 (42.76)	22.84 (38.33)	65.27 (65.27)	0 (1.93)
Median (mean) variation (%) in MV units per 1000 cancer cases (2012-2018)	-9.79 (-2.79)	-8.88 (+5.88)	-10.47 (-5.39)	-7.37 (-0.60)	-11.3 (-11.3)	-40.56 (-45.27)

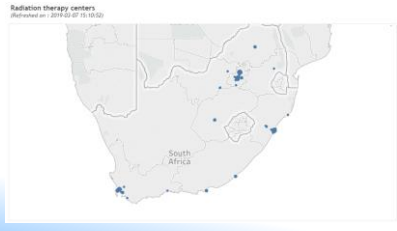## Progress in low income countries over the past 20 years (Africa)

SAF example (all centres) DIRAC

25% population in Gauteng

59	93	90	3
RT Centers	Equipment	Linear Accelerator	Radionuclide Therapy

Radiation therapy centers
(Refreshed on : 2019-03-07 15:10:52)

SAF example (Gauteng) DIRAC

13.9 mi est. population in Gauteng (2019)

19	32	30	2
RT Centers	Equipment	Linear Accelerator	Radionuclide Therapy

Radiation therapy centers
(Refreshed on : 2019-03-07 15:10:52)
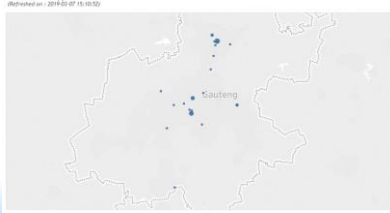
SAF example (Gauteng public sector)

| 10.4 mi est. public population in Gauteng | **2** RT Centers | **11** Equipment | **9** Linear Accelerator | **2** Radionuclide Therapy |

Radiation therapy centers
(Refreshed on : 2019-02-07 15:10:52)

## Top 10 causes of death (WHO, 2018)

- Globally, "trachea, bronchus, lung cancers" was no. 9 in 2000; no. 6 in 2016
- Global data skewed by upper MIC and HIC
- In LIC and lower MIC, cancer not in the top 10 causes of death (37% deaths are due to NCDs, cf. 88% in HIC)

Cause of death 2016	LIC	LOWER MIC	UPPER MIC	HIC
No. 1	Lower respiratory infections	Ischaemic heart disease	Ischaemic heart disease	Ischaemic heart disease
No. 2	Diarrheal diseases	Stroke	Stroke	Stroke
No. 3	Ischaemic heart disease	Lower respiratory infections	COPD	Alzheimer and other dementias

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Lack of cancer care guidelines in LMICs

- Cites extension of cancer treatment to remote areas though a coordinated hub and spoke model (TMC)
- Use of tax revenue to subsidise national insurance funds for cancer coverage (Kenya).
- Economic downturns have led to many losing their health benefit (Brazil 2015)
- Availability of specialized professionals affects equity in access to multidisciplinary care e.g. surgeons.
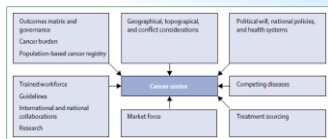
B Sirohi, et. al. Lancet Oncology August 2018

Investment needed to address the gap

- Major difference in region (population dependent). U-MIC needed the most costly intervention overall
- Taking into account the income setting and the need for additional radiotherapy services
- Adjusted to the case mix
- Costing includes human resources, facilities as well as equipment procurement and sustainability.
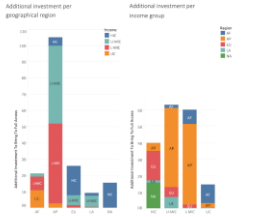

Fig 2. Additional investment needed to provide full access to radiotherapy by geographic region and by income group. AF, Africa; AP, Asia Pacific; EU, Europe; LA, Latin America; NA, North America; HIC, high-income country; U-MIC, upper middle-income country; L-MIC, lower middle-income country; LIC, low-income country.

Zubizarreta, et. al. Clinical Oncology 2017

Radiotherapy capacity

- The size of the dot/circle (a country) represents the annual number of fractions delivered (assuming an 8h working day) as a function of GNI 2013.
- Coverage > 1 means capacity is available
- Coverage = 1 means that access is theoretically near perfect.
- Since information on personnel and workload are not reliable, DIRAC data alone were used to calculate capacity and the cancer burden was used to estimate demand.
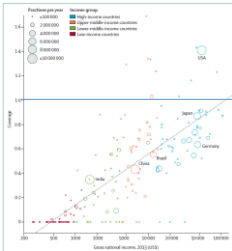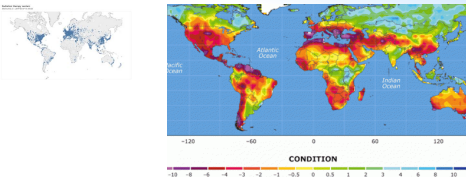
Atun, et al. The Lancet Oncology Commission. 2015

Figure 10: Radiotherapy coverage as a function of gross national income.
Each circle represents a distinct country. The diameter of the circle is the actual yearly number of fractions delivered. Coverage is reported for an assumed 8 h operating day.

The future?

https://nbharbinger.wordpress.com/2012/12/11/new-brunswick-low-risk-for-drought-by-2030/
Model using mean surface air temperature, precipitation, humidity, net radiation and wind speed.
Aiguo, Dai, National Center for Atmospheric Radiation, USA , Jan/Feb 2011

Way forward

- Uptime data analysis is sparse and reliable data is 'difficult' to obtain
- Recognize and promote sustainable access
- I ≠ intellect, interest, intelligence or inspiration…
- What should the indicators for a successful project be? It is clear that counting only installed "operational" radiotherapy units is not the solution.
- Quality indicators for radiotherapy efficacy and efficiency are not widely available.

Way forward

- Ethical issues
- "Global Radiology" sub-specialty
- World Health Imaging System Radiographic system; Lodox scanner
- A good example could be small islands or countries with low population density on large tracts of land – can we consider cross training staff and a completely non-traditional solution, e.g. operate 3 hours per day, use clinical oncologists, use technologists that are dual-trained, remote oversight, etc.?

Way forward

- "Non-HIC" inter-regional twinning is currently not a popular approach despite mechanisms, e.g. BRICS. How to link MICs or LICs with each other?
- MIC partnership with LIC
- Investigate (reward) innovative indigenous solutions that are developed together with experienced, indigenous, local professionals. Some regions are no longer reporting brain drain and this could be an opportunity.