We are in a race against time for smarter development
are we using science to build the future we want?

Are we using science for smarter development?

UNESCO Science Report (2021)

Susan Schneegans
Editor-in-Chief
Brussels, 9 February 2022
Research spending up in most regions but G20 still accounts for 9/10ths of input/output

32 countries raised research spending by at least 0.1% of GDP: UAE, Jordan, Iran, Burkina Faso, Malaysia, Poland, Germany, etc.

13 countries lowered research spending by at least 0.1% of GDP: Slovenia, Finland, Ireland, Kuwait, Ethiopia, etc.

China = 4/10th of growth

Asian share of GERD

Data source: UNESCO Institute for Statistics

Why the steep drop in research investment in Latin America?

Latin America: two primary growth patterns:
❖ **industrial exports**: goods imported then re-exported with little value addition
❖ **exports of natural resources**.

Neither growth pattern effective in producing innovation.

During commodities boom, investment channelled mainly towards economic expansion, rather than towards reinforcing existing infrastructure or supporting innovation and risk-taking.

Since end of commodities boom in 2014: stagnant economic growth, coupled with drop in research spending in Argentina, Brazil and Mexico.

Students practising maintenance on aircraft engines for the skilled technician training programme at Mexico’s National Aeronautics University. © Bénédicte Desrus
❖ Greater convergence: China and USA both raising research effort

❖ Strong growth in Germany, Rep.Korea

❖ Lethargic growth in Japan, France, UK and Italy

❖ India now spends more on research than France, UK and Italy
Japan’s growth strategy, **Society 5.0 (2017)**: transforming the Japanese way of life by using digital technologies to compensate for a declining population.

- If there are not enough staff in care homes, robots will help to look after people.
- With fewer people to work on farms, self-driving tractors will be used in the fields.
- Towns will receive decentralized energy services tailored to their needs.

By introducing AI into the workplace and wider society, it is hoped that depopulation and ageing will cease to be disadvantages in a less labour-intensive economy.
China and USA leading output in AI, quantum patents

❖ China’s mega-engineering programmes to 2030 include quantum computing and brain science.

❖ USA introduced BRAIN initiative (2016), plans to double government investment in research on quantum information science and AI between 2019 and 2022.

❖ 150 Chinese and 6 US universities among top 500 for publications on AI; USA has companies (IBM and Microsoft) with biggest AI portfolios.

❖ Chinese technology being taken up by other countries: receipts rose by 570% between 2010 and 2018 (Data: World Bank).

❖ China IP protection laws: making it easier for foreigners to do business in China and to protect strategic Chinese industries.

❖ Share of GERD on basic research: China: (5.5%), Japan (13%), USA (17%), 22%, Italy (22%), Switzerland (42%).

### Share of basic research financed by industry (%)

<table>
<thead>
<tr>
<th>Country</th>
<th>2012</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>10%</td>
<td>27%</td>
</tr>
<tr>
<td>USA</td>
<td>23%</td>
<td>30%</td>
</tr>
</tbody>
</table>

**Contributing factor:**

**Big data analytics** vital to tech-based industries: social media, automotive, aeronautics, pharmaceuticals, etc..

- e.g. AI being used to determine the structure of atoms and molecules for industrial applications: *computational materials science, computational drug design.*

- Switzerland striving to expand innovation culture beyond pharma and chemicals giants: tax reform for research-intensive firms and Swiss Innovation Park (2016): advanced manufacturing (e.g. cyberphysical systems, 3D printing), smart buildings and robotics, etc., all reliant on big data.
EU leading for green and digital patents in 2017

Figure 9.12: Evolution in green and digital patents awarded to inventors from the European Union and selected countries, 2000–2017

- Patents that are both green and digital, by origin
- Green patents, by origin

Source: EIB (2021), author’s calculations based on PATSTAT data
Number of African tech hubs has more than doubled since 2016


Figure 20.2: Active tech hubs in Africa, 2020

Data source: Briter Bridges

Trends in the UNESCO Science Report (2021)
Industry 4.0 could perpetuate gender imbalance in science and engineering

Women remain a minority in:
❖ digital information technology,
❖ computing,
❖ physics,
❖ Mathematics
❖ engineering.

In academia, female researchers have shorter, less well-paid careers. Their work is underrepresented in high-profile journals and they obtain less research funding than men.

In industry, women underrepresented in company leadership and technical roles. Corporate attitudes are evolving, however, as studies link investor confidence and greater profit margins to a diverse workforce.

22% = women AI professionals
28%* = female graduates in engineering

* data source: UNESCO Institute for Statistics
Industry 4.0 could perpetuate gender imbalance in science and engineering

**Gender trends in the UNESCO Science Report (2021)**

- **53%*** female bachelor’s and master’s graduates
- **44%*** female PhDs
- **33%*** female researchers
- **12%** women in academies of science
- **2%** venture capital for tech women-led start-ups

Data source: UNESCO Institute for Statistics*; TechRadius survey of 700 companies worldwide, 2019**
Worldwide, 14% more researchers (FTE), 2014-2018, but just 1.6% more expenditure per researcher.

**Contribution to growth in the number of researchers worldwide, 2014–2018 (%)**
Top ten contributors and rest of the world

- **China** 30.7
- **European Union** 26.4
- **USA** 9.3
- **Rep. Korea** 5.6
- **India** 5.6
- **Iran** 5.1
- **Turkey** 2.8
- **Thailand** 2.5
- **Other** 9.3

**38** countries gained at least 15% more researchers per million inhabitants (FTE), biggest gains: Jordan, Mauritius, Iran, Ethiopia, B&H, Honduras, Iraq, Oman.

**4** countries lost at least 15% of researchers per million inhabitants (FTE).

Data source: UNESCO Institute for Statistics.
Strong growth in scientific publishing, 2015–2019, particularly in cross-cutting strategic tech

Growth in scientific publishing overall (%) (orange bars) and for cross-cutting strategic tech (%) (grey bars)

Cross-cutting strategic tech:
- Faster growth (+33%) than scientific publishing overall (+21%).
- 18% of scientific publications in 2019, behind health (34%).
- Low- and lower middle-income countries show strongest growth.
- Output highest for artificial intelligence, energy and materials science.

Number of global publications in cross-cutting strategic tech, 2018-2019

Data source: Scopus (Elsevier); data treatment by Science-Metrix
Strong growth since 2016 in Afghan academic publishing on energy, AI and bio-informatics

Data source: Scopus (Elsevier); data treatment by Science-Metrix

‘Whoever becomes the leader in AI will rule the world’ President Putin

Figure 1.13: Trends in scientific publishing on artificial intelligence and robotics

Data source: Scopus (Elsevier); data treatment by Science-Metrix

Strong growth in global share:
- India,
- Russian Federation,
- Malaysia, Indonesia
- and Ukraine

Also:
- in Morocco, Viet Nam, Colombia, Ecuador, Iraq, etc.
China dominates academic publishing on materials science

Figure 1.15: Trends in scientific publishing on materials science

Share of global publications on materials science, 2011, 2015 and 2019 (%)
Among countries contributing to at least 1% in 2019; data labels are for 2019

The European Union contributed to 19.3% of publications on materials science in 2019.

Global publications on materials science
- 93,033 in 2019
- 63,705 in 2015
- 52,608 in 2011

Strong growth in global share:
- Russian Fed., India, Indonesia, Malaysia
- Also
- Iraq, Viet Nam, South Africa, Nigeria, etc.

Data source: Scopus (Elsevier); data treatment by Science-Metrix
Energy research: China dominates academic energy research (includes fossil fuels and nuclear)

Figure 1.14: Trends in scientific publishing on energy

Share of global publications on energy, 2011, 2015 and 2019 (%)
Among countries contributing to at least 1% in 2019; data labels are for 2019

The European Union contributed to 23.7% of publications on energy topics in 2019.

Global publications on energy

- 108,129 in 2019
- 86,771 in 2015
- 70,215 in 2011

Strong growth in global share: China and India

Also Pakistan, Iraq, Morocco, Tunisia, Viet Nam, Ecuador, etc.
Sustainable energy research: share of high-income countries shrinking

Share of global output on sustainable energy from high-income economies (%)

- Nuclear fusion
- Hydropower
- Wind turbine technologies
- Smart grid technologies
- Cleaner fossil fuel technology
- Biofuels and biomass
- Photovoltaics
- Geothermal energy
- Hydrogen energy
- Radioactive waste management
- Nuclear fusion

Data source: Scopus (Elsevier); data treatment by Science-Metrix

Just 2.4% of scientific publications concerned sustainable energy between 2016 and 2019.

Publication trends in the UNESCO Science Report (2021)
Developing countries publishing more than before on sustainable energy

<table>
<thead>
<tr>
<th>Region</th>
<th>2012–2015</th>
<th>2016–2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>East &amp; Southeast Asia</td>
<td>74,148</td>
<td>107,515</td>
</tr>
<tr>
<td>European Union</td>
<td>43,699</td>
<td>70,611</td>
</tr>
<tr>
<td>North America</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Asia</td>
<td>12,228</td>
<td>44,677</td>
</tr>
<tr>
<td>Eastern Europe &amp; West Asia</td>
<td>10,092</td>
<td>17,990</td>
</tr>
<tr>
<td>Latin America</td>
<td>8,479</td>
<td>12,892</td>
</tr>
<tr>
<td>Arab States</td>
<td>6,440</td>
<td>13,159</td>
</tr>
<tr>
<td>Oceania</td>
<td>6,101</td>
<td>8,245</td>
</tr>
<tr>
<td>European Free Trade Association</td>
<td>5,085</td>
<td>6,121</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>2,038</td>
<td>6,121</td>
</tr>
<tr>
<td>Southeast Europe</td>
<td>546</td>
<td>695</td>
</tr>
<tr>
<td>Central Asia</td>
<td>194</td>
<td>464</td>
</tr>
<tr>
<td>Caribbean</td>
<td>127</td>
<td>155</td>
</tr>
</tbody>
</table>

Output has doubled in:
- South Asia
- Arab States
- Sub-Saharan Africa
- Central Asia

Little change in: North America

Data source: Scopus (Elsevier); data treatment by Science-Metrix.
Lower middle-income countries show strongest growth in sustainability science

Example:

**Smart-grid technologies**
Lower middle-income countries: 5% → 18%

0.38% of global publications

World total:

Examples of steep rise:
Philippines: 5/65
India: 1,624/5,177
Climate-ready crops: low-income countries publishing much more, strong int'l collaboration

Example:

**Climate-ready crops**: output has doubled from low starting point
Low-income countries 4.5% → 11.4%

**World total**:
- 1 660 (2012–2015)

**Surge in countries such as**:
- Italy 78/137:
- Mexico: 57/133
- Australia: 121/235
- Kenya: 39/93
- South Africa: 26/109

Data source: Scopus (Elsevier); data treatment by Science-Metrix; data visualization by Values Associates
Top ten topics in the EU28 by growth rate, 2012–2019
In descending order by volume of publications

- Greater battery efficiency: 19,378 (5.29)
- Precision agriculture: 3,212
- Help for smallholder food producers: 1,813
- Eco-alternatives to plastics: 1,813
- Climate-ready crops: 1,442
- Floating plastic debris in the ocean: 1,252
- Local impact of climate-related hazards & disasters: 1,042
- Minimize poaching & trafficking of protected species: 593
- Local disaster risk reduction strategies: 443
- New tech to protect from climate-related hazards: 366

Data source: Scopus (Elsevier); data treatment by Science-Metrix

Trends in the UNESCO Science Report (2021)
### Sustainability science not a priority: selected research topics, 2012–2019

<table>
<thead>
<tr>
<th>Topic</th>
<th>Number of Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable withdrawal &amp; supply of freshwater</td>
<td>12,736 (0.06)</td>
</tr>
<tr>
<td>Pest-resistant crops</td>
<td>12,053 (0.06)</td>
</tr>
<tr>
<td>Geothermal energy</td>
<td>11,826 (0.06)</td>
</tr>
<tr>
<td>Coastal eutrophication</td>
<td>11,190 (0.06)</td>
</tr>
<tr>
<td>Precision agriculture</td>
<td>9,627 (0.05)</td>
</tr>
<tr>
<td>Maintain genetic diversity of food crops</td>
<td>8,541 (0.04)</td>
</tr>
<tr>
<td>Carbon pricing</td>
<td>6,261 (0.03)</td>
</tr>
<tr>
<td>Eco-alternatives to plastics</td>
<td>5,247 (0.03)</td>
</tr>
<tr>
<td>Socio-ecological impact of terrestrial protected areas</td>
<td>4,770 (0.02)</td>
</tr>
<tr>
<td>Climate-ready crops</td>
<td>4,769 (0.02)</td>
</tr>
<tr>
<td>Help for smallholder food producers</td>
<td>4,699 (0.02)</td>
</tr>
<tr>
<td>Water harvesting</td>
<td>4,115 (0.02)</td>
</tr>
<tr>
<td>Ocean acidification</td>
<td>3,605 (0.02)</td>
</tr>
<tr>
<td>Local impact of climate-related hazards &amp; disasters</td>
<td>2,909 (0.01)</td>
</tr>
<tr>
<td>National &amp; urban greenhouse-gas emissions</td>
<td>2,352 (0.01)</td>
</tr>
<tr>
<td>Floating plastic debris in the ocean</td>
<td>2,327 (0.01)</td>
</tr>
<tr>
<td>Sustainably manage marine tourism</td>
<td>1,767 (0.01)</td>
</tr>
<tr>
<td>Ecosystem-based approaches in marine environments**</td>
<td>1,380 (0.01)</td>
</tr>
<tr>
<td>Minimize poaching &amp; trafficking of protected species</td>
<td>1,276 (0.01)</td>
</tr>
<tr>
<td>Extent of water-related ecosystems</td>
<td>1,239 (0.01)</td>
</tr>
<tr>
<td>Ecosystem-based approaches in protected areas on land</td>
<td>1,137 (0.01)</td>
</tr>
<tr>
<td>Local disaster risk reduction strategies</td>
<td>1,039 (0.01)</td>
</tr>
<tr>
<td>Transboundary water resources</td>
<td>864 (0.00)</td>
</tr>
<tr>
<td>New tech to protect from climate-related hazards</td>
<td>824 (0.00)</td>
</tr>
</tbody>
</table>

Number of scientific publications on **artificial intelligence & robotics** over same period: **900,000**

Data source: Scopus (Elsevier); data treatment by Science-Metrix

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**Trends in the UNESCO Science Report (2021)**
Thank you for your attention

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www.unesco.org/reports/science/2021/en