Without adequate resources, it is unlikely that [research and education] policies will bring about effective change.

Dilupa Nakandala and **Ammar Malik**

Mahfuza answers farmer Nojrul Islam's question about using fertilizer on his crops by showing him a video on her laptop offering advice. In rural Bangladesh, the Info Ladies service brings internet services to men and women who need information but lack the means to access the web.
Photo © GMB Akash/Panos Pictures

21 · South Asia

Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka

Dilupa Nakandala and Ammar Malik

INTRODUCTION

Healthy economic growth

To the outsider, the seven economies of South Asia covered in the present chapter may appear to possess similar characteristics and dynamics. In reality, however, they are quite diverse. Afghanistan, Bangladesh and Nepal are low-income economies, Bhutan, Pakistan and Sri Lanka are lower middle-income economies and the Maldives is an upper middle-income economy.

According to the 2013 UNDP human development index, only Sri Lanka has achieved a high level of human development. Bangladesh, Bhutan and Maldives enjoy medium levels and the remainder are still at a stage of low development. Between 2008 and 2013, human development progressed in Bangladesh, the Maldives, Nepal and Sri Lanka but receded slightly in Pakistan, mainly due to the unstable security situation in parts of the country.

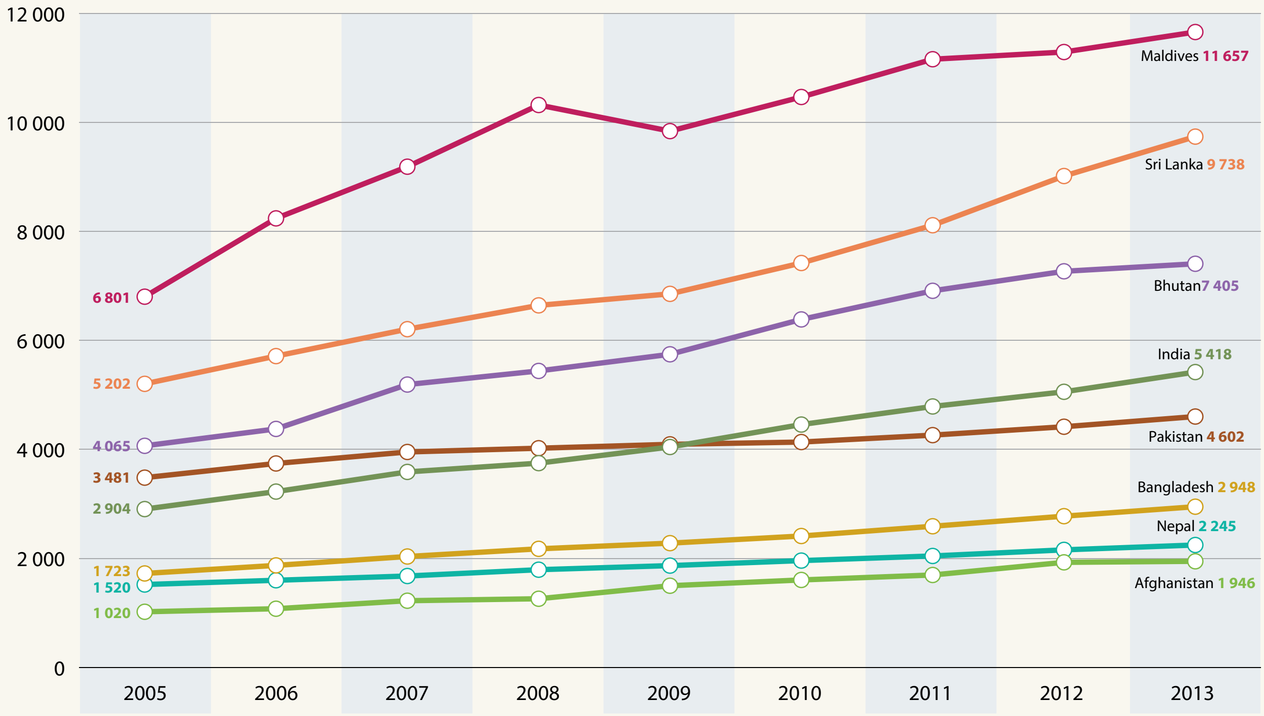
Three out of four South Asians are Indian. This single country accounts for 80% of the region's GDP of US$ 2 368 trillion. As India is the object of a separate chapter (see Chapter 22), the present essay will focus on the other seven members of the South Asian Association for Regional Cooperation (SAARC). Excluding India, GDP grew by a healthy 6.5% in the region in 2013. Sri Lanka reported the fastest progression (7.25%) and the Maldives (3.71%) and Nepal (3.78%) the slowest. GDP per capita, on the other hand, has risen fastest in the Maldives, followed by Sri Lanka (Figure 21.1).

FDI insufficient but trade growing

The rise in export and import trade volumes in recent years confirms the growing integration of South Asia in the global economy. Bangladesh has even managed to outperform its neighbours, with its exports progressing from 16% to 19.5% of GDP between 2010 and 2013. Moreover, Bangladesh managed to maintain a stable level of exports and foreign direct investment (FDI) at the height of the global financial crisis in 2008–2009. Amjad and Din (2010) have identified the insufficient diversification of exports and low domestic consumption as shock amplifiers during the global crisis; for them, sound economic management helped maintain macro-economic stability in Bangladesh, despite global food and fuel price hikes over this period.

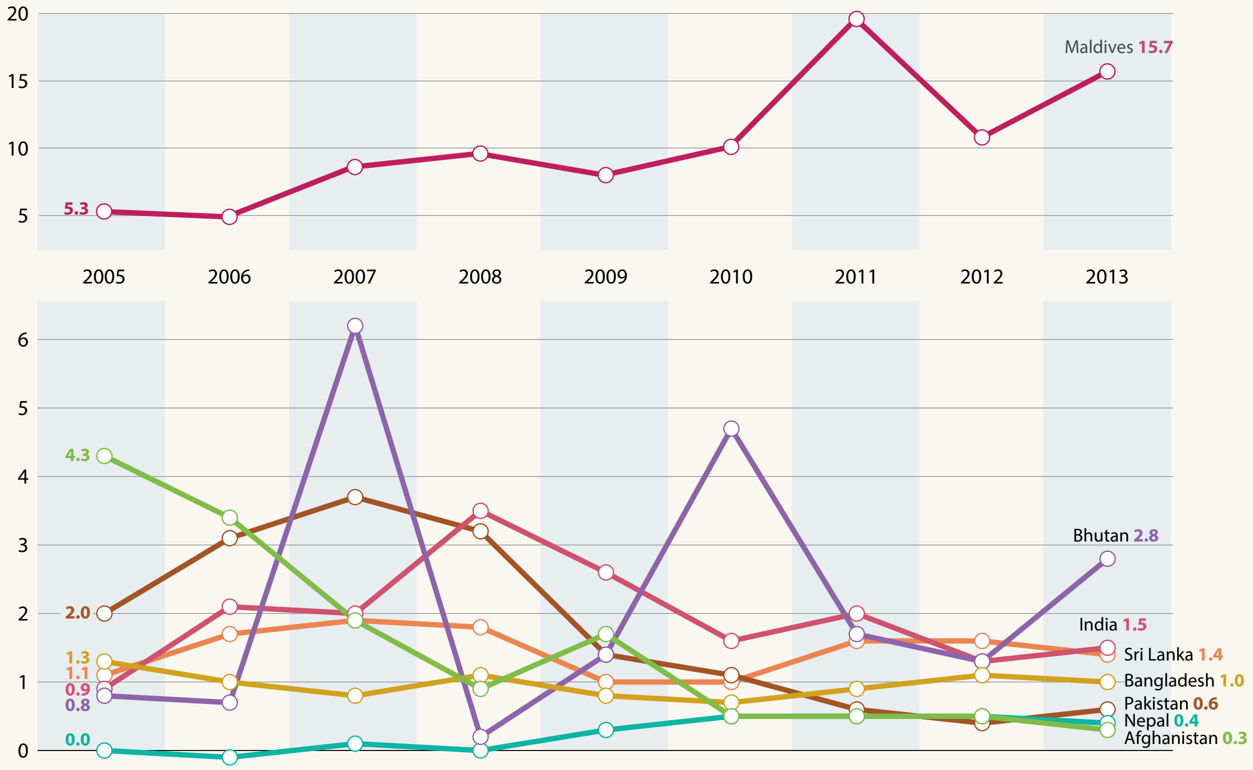
Figure 21.1: **GDP per capita in South Asia, 2005–2013**

In current PPP$



Source: World Bank's World Development Indicators, April 2015

Figure 21.2: **FDI inflows to South Asia as a share of GDP, 2005–2013 (%)**



Source: World Bank's World Development Indicators, accessed April 2015

Afghanistan and Pakistan, in particular, were less fortunate. The Maldives, on the other hand, sailed through the global financial crisis to become an increasingly attractive destination for FDI (Figure 21.2). It is the exception which confirms the rule. With inflows not exceeding 5% of GDP over the past decade in all but Bhutan and the Maldives, South Asia is hardly a pole of attraction for FDI. The total amount of announced greenfield investments (see the glossary, p. 738) in South Asia dropped to US$ 24 million in 2013, down from US$ 87 million in 2008. India hosted 72% of the region's greenfield FDI in 2013.

Political instability has long been a barrier to development in South Asia. Although Sri Lanka emerged from three decades of civil war in 2009 and the Nepalese civil war has been over since 2006, the rehabilitation and reconstruction of these nations will be long-term enterprises. There was a smooth political transition in Sri Lanka in January 2015, when Maithripala Sirisena was elected president in an election called two years ahead of schedule by the incumbent president Mahinda Rajapaksa. Two months later, in the Maldives, former president Mohamed Nasheed was jailed for 13 years following a trial which the United Nations' High Commissioner for Human Rights described as 'a rushed process'. In Afghanistan, civil society has developed considerably since 2001 but the protracted negotiations to form a government after the presidential election of April 2014 reflect the fragility of the ongoing transition to democracy; this process will need to be consolidated by the time the forces of the North Atlantic Treaty Organization (NATO) withdraw from Afghanistan in 2016.

Barriers remain to intra-regional trade

South Asia remains one of the world's least economically integrated regions, with intraregional trade accounting for merely 5% of total trade (World Bank, 2014). It has been nine years since the South Asian Free Trade Area (SAFTA) agreement entered into force on 1 January 2006, committing the eight[1] signatories (with India) to reducing customs duties on all traded goods to zero by 2016.

Nine years on, regional trade and investment remain limited, despite countries having embraced global trade liberalization. This is due to a host of logistical and institutional barriers, such as visa restrictions and the lack of regional chambers of commerce. Even though various studies have argued that greater trade would produce net gains in social welfare, businesses are unable to take advantage of potential synergies, owing to non-tariff barriers such as cumbersome processes for obtaining customs clearance (Gopalan *et al.*, 2013).

1. Afghanistan ratified the agreement in May 2011.

Since its inception in 1985, SAARC has failed to emulate the success of the neighbouring Association of Southeast Asian Nations in fostering regional integration in trade and other areas, including in science, technology and innovation (STI). Tangible results largely elude SAARC, beyond a series of agreements and regular summits involving heads of government (Saez, 2012). Several explanations have been put forward but the most prominent of these remains the persistently tense relations between India and Pakistan, traditional security concerns having been fuelled by the threat of terrorism in recent years. At the November 2014 SAARC summit, Indian Prime Minister Narendra Modi nevertheless invited SAARC members to offer Indian companies greater investment opportunities in their countries, assuring them of greater access to India's large consumer market in return. After a tragic earthquake struck Nepal on 25 April 2015, killing more than 8 000 and flattening or damaging more than 450 000 buildings, all SAARC members were quick to show their solidarity through the provision of emergency aid.

In the past decade, India has assumed responsibility for hosting two regional bodies, the South Asian University (Box 21.1) and the Regional Biotechnology Centre for training and research (see p. 612). These success stories illustrate the potential of STI for fostering regional integration. There are also instances of bilateral co-operation in STI. For instance, an Indo-Sri Lankan Joint Committee on Science and Technology was set up in 2011, along with an Indo-Sri Lankan Joint Research Programme. The first call for proposals in 2012 covered research topics in food science and technology; applications of nuclear technology; oceanography and Earth science; biotechnology and pharmaceuticals; materials science; medical research, including traditional medical systems; and spatial data infrastructure and space science. Two bilateral workshops were held in 2013 to discuss potential research collaboration on transdermal drug delivery systems and clinical, diagnostic, chemotherapeutic and entomological aspects of Leishmaniasis, a disease prevalent in both India and Sri Lanka that is transmitted to humans through the bite of infected sandflies.

Box 21.1: **The South Asian University: shared investment, shared benefits**

The South Asian University opened its doors to students in August 2010. It plans to become a centre of excellence with world-class facilities and staff. It currently offers seven PhD and master's programmes in applied mathematics, biotechnology, computer science, development economics, international relations, law and sociology.

Students come predominantly from the eight SAARC countries and enjoy heavily subsidized tuition fees. Some students from non-SAARC countries may also be admitted on a full cost-recovery basis. Admission is governed by a quota system, whereby each member country is entitled to a specific number of seats in each programme of study. Every year, the university conducts a SAARC-wide entrance test in all the major cities of South Asia. PhD aspirants also have to present their thesis proposal and undergo a personal interview. In 2013, the university received 4 133 applications for its programmes from all eight South Asian countries, double the number in 2012. There were 500 applications alone for the 10 places on offer for the doctoral programme in biotechnology.

The university is being temporarily hosted by the Akbar Bhawan Campus in Chanakyapuri, New Delhi, before moving to its 100-acre campus in Maidan Garhi in South Delhi by 2017. The task of designing the campus has been entrusted to a Nepalese firm of architects through a competitive bidding process.

The capital cost of establishing the university is being covered by the Indian government, whereas all eight SAARC member countries share the operational costs in mutually agreed proportions.

The university focuses on research and postgraduate level programmes. It will ultimately have 12 postgraduate faculties, as well as a Faculty of Undergraduate Studies. At full strength, the university will count 7 000 students and 700 teachers. There are also plans to establish an Institute of South Asian Studies on campus.

Degrees and certificates awarded by the university are recognized by India's University Grants Commission and by other SAARC countries.

Attractive salary packages and benefits have been designed to attract the best teachers. Although they tend to come from the eight SAARC countries, up to 20% may come from other countries.

The idea of a South Asian University was mooted by the Prime Minister of India at the 13th SAARC Summit in Dhaka in 2005. Prof. Gowher Rizvi, a well-known historian from Bangladesh, was then entrusted with the task of preparing the concept paper, in consultation with SAARC countries. An interministerial Agreement for the Establishment of the South Asian University clinched the deal on 4 April 2007 during the following SAARC Summit in New Delhi.

Source: www.sau.ac.in

TRENDS IN EDUCATION

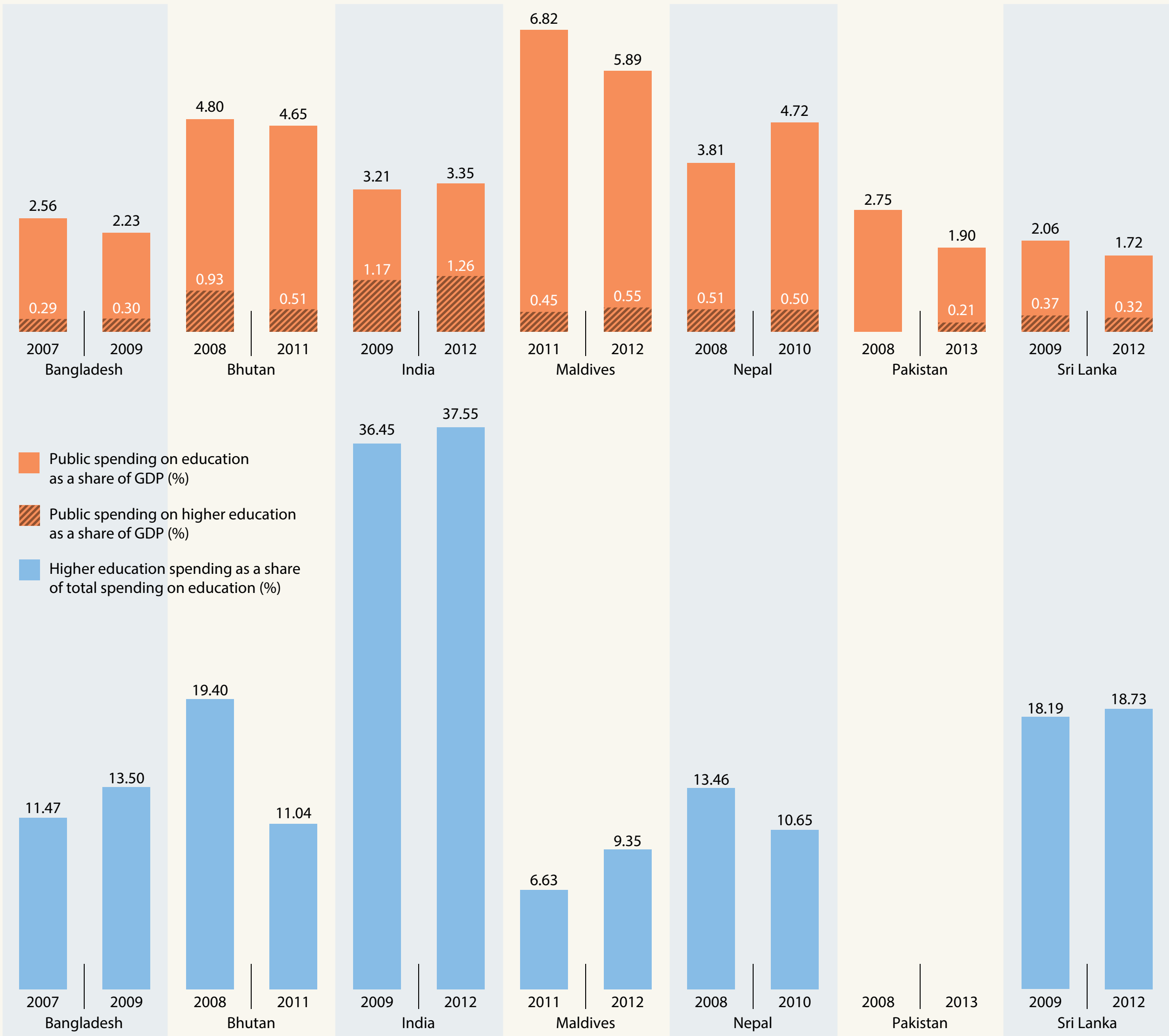
Underfunded reforms of higher education

Over the past decade, South Asian countries have embarked on an energetic drive to achieve the Millennium Development Goal (MDG) of universal primary education by 2015. Despite having rapidly achieved this target, the Maldives has consistently devoted between 5% and 7% of GDP to education over this period, more than any of its neighbours (Figure 21.3).

In all countries, higher education has had to take a back seat during this drive; the most recent data available reveal that spending on higher education amounts to just 0.3–0.6% of GDP, compared to 1.3% of GDP in India in 2012. Now that countries are on the verge of achieving universal primary education, there are growing calls for them to spend more on higher education, particularly since modernization and diversification of the economy are at the heart of their current development strategies. However, in all but Nepal, spending on education has actually been curtailed in recent years and, even in Nepal, the share allocated to higher education has stagnated (Figure 21.3).

Afghanistan is pursuing an ambitious reform of its higher education system that is yielding some impressive results, despite dependence on uncertain donor funding. Between 2010 and 2015, student enrolment doubled, for instance, as

Figure 21.3: **Public expenditure on education in South Asia, 2008 and 2013 or closest years**



Note: Data are unavailable for Afghanistan.

Source: UNESCO Institute for Statistics, April 2015; for Pakistan in 2013: Ministry of Finance (2013) *Federal Budget 2014–2015: Budget in Brief.* See: http://finance.gov.pk/budget/Budget_in_Brief_2014_15.pdf did the number of faculty members in public universities. The government adopted a gender strategy in 2013 to raise the ratio of women among students and faculty (see p. 579).

Available data for Bangladesh on tertiary enrolment show a steep rise in PhD students in engineering between 2009 and 2011 (from 178 to 521), despite a modest government investment. In Sri Lanka, the number of PhD students has climbed equally rapidly in engineering but also in science and agriculture. There is no breakdown by field of study for Pakistan but the number of PhD students also shows rapid growth (Tables 21.1 and 21.2). Pakistan and Sri Lanka now have the same share of university students enrolled in PhD programmes (1.3%) as Iran (see Figure 27.5).

ICT policies but infrastructure needs to catch up

In recent years, South Asian governments have developed policies and programmes to foster the development and use of information and communication technologies (ICTs). For instance, the Digital Bangladesh programme is central to realizing the country's vision of becoming a middle-income economy by 2021 (see p. 581). The World Bank and others are partnering with governments to accelerate the movement. Examples are the Youth Solutions! Competition for budding entrepreneurs (Box 21.2) and Bhutan's first information technology (IT) park (see p. 584).

Nowhere is this drive more visible than in education. In 2013, Bangladesh and Nepal published national plans to mainstream ICTs in education. Sri Lanka has adopted a similar plan and Bhutan is currently developing its own but work still needs to be done in the Maldives to develop a policy on ICTs in education (UIS, 2014b). The realities of a patchy, unreliable electricity supply are often fundamental obstacles to the diffusion of ICTs in rural and remote areas. In Pakistan, just 31% of rural primary schools have a reliable electricity supply, compared to 53% in urban centres, and power surges and brownouts are common in both. In Nepal, only 6% of primary schools and 24% of secondary schools had electricity in 2012 (UIS, 2014b). Another factor is the poor provision of telecommunication services through a fixed telephone line, cable connection and mobile phone technology, making it difficult to connect school computer systems with the wider network. With the exception of the Maldives, these critical pieces of ICT infrastructure are not universally available in the region. In Sri Lanka, for instance, only 32% of secondary schools have telephones.

As shown in Figure 21.4, the number of mobile phone subscribers is much higher in South Asia than the number of internet users. Mobile phone technology is increasingly being used by teachers in developing economies for both educational and administrative purposes (Valk *et al.*, 2010).

Table 21.1: **Tertiary enrolment in Bangladesh, Pakistan and Sri Lanka, 2009 and 2012 or closest years**

	Total	Post-secondary diploma	Bachelor's and master's degrees	PhD
Bangladesh (2009)	1 582 175	124 737	1 450 701	6 737
Bangladesh (2012)	2 008 337	164 588	1 836 659	7 090
Pakistan (2009)	1 226 004	62 227	1 148 251	15 526
Pakistan (2012)	1 816 949	92 221	1 701 726	23 002
Sri Lanka (2010)	261 647	12 551	246 352	2 744
Sri Lanka (2012)	271 389	23 046	244 621	3 722

Source: UNESCO Institute for Statistics, April 2015

Table 21.2: **University enrolment in Bangladesh and Sri Lanka by field of study, 2010 and 2012 or closest years**

	Science		Engineering		Agriculture		Health	
	Bachelor's and master's degrees	PhD	Bachelor's and master's degrees	PhD	Bachelor's and master's degrees	PhD	Bachelor's and master's degrees	PhD
Bangladesh (2009)	223 817	766	37 179	178	14 134	435	23 745	1 618
Bangladesh (2012)	267 884	766	62 359	521	21 074	445	28 106	1 618
Sri Lanka (2010)	24 396	250	8 989	16	4 407	56	8 261	1 891
Sri Lanka (2012)	28 688	455	14 179	147	3 259	683	8 638	1 891

Source: UNESCO Institute for Statistics, April 2015

Box 21.2: South Asia Regional Youth Grant competitions

A competition launched in 2013 in Bangladesh, the Maldives, Nepal and Sri Lanka offers young people from each country the opportunity to win a grant of US$ 10 000–20 000 to implement an innovative project of one year's duration in the field of IT.

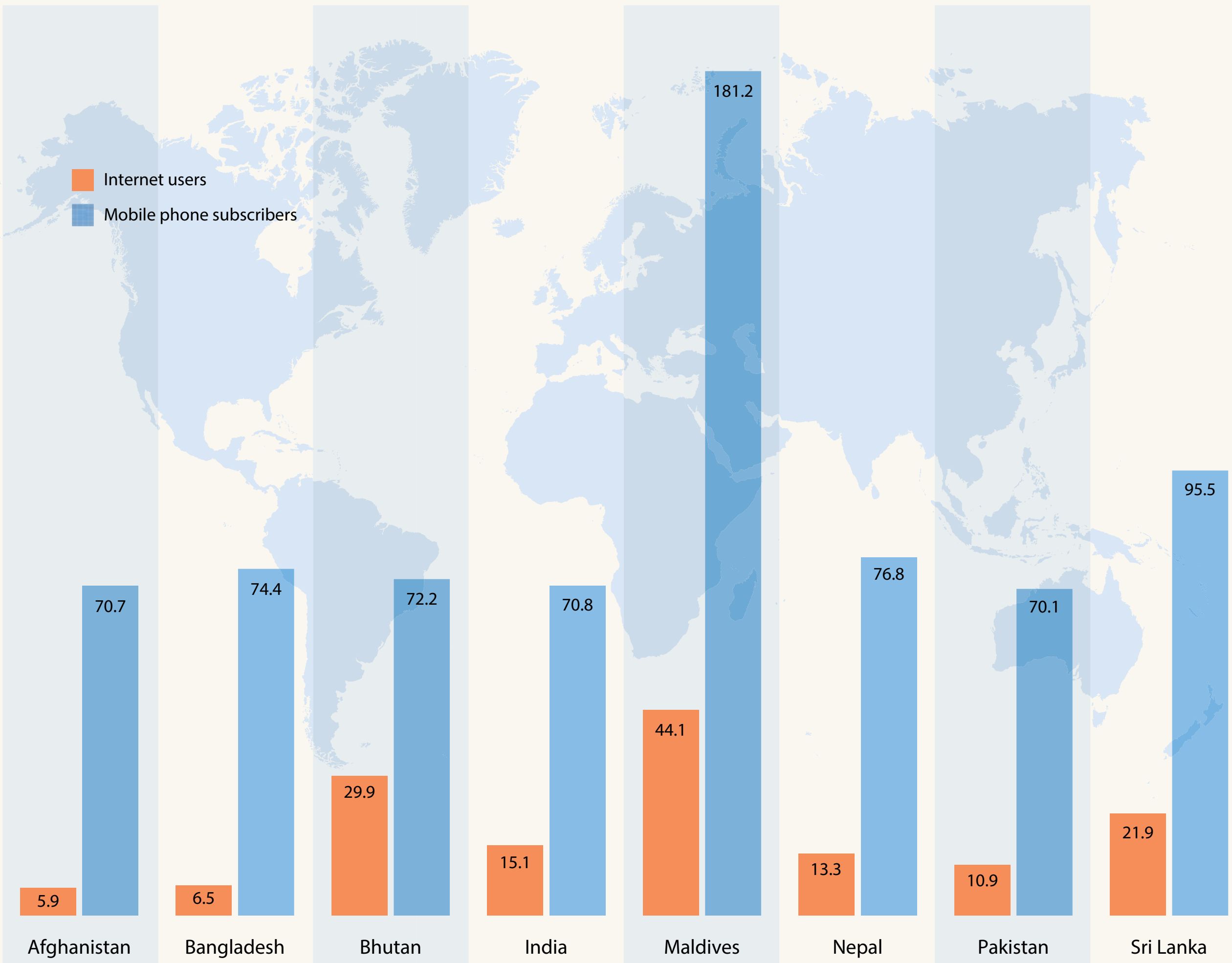
The aim is to identify innovative ideas that are ripe for the picking and allow their young creators to develop these. The competition targets rural youth-led social enterprises. Youth-led organizations and non-governmental organizations with two years of operation are eligible to apply, each proposal needing to have a strong focus on sustainability. The ultimate goal is to augment and diversify employment opportunities for the young.

The theme of the first grant competition was Youth Solutions! Technology for Skills and Employment (2013) and that of the second Coding Your Way to Opportunity (2014).

The scheme is the fruit of a partnership formed in March 2013 by the World Bank, Microsoft Corporation and Sarvodaya Fusion of Sri Lanka, the latter being the implementing partner. Microsoft and the World Bank, meanwhile, shortlist the innovative proposals with the support of an external evaluation panel, based on criteria that include the use of ICTs as a tool; skills development; the provision of employment opportunities; novelty; sustainability; the participatory nature; and the measurability of the outcome.

Source: World Bank

Figure 21.4: **Internet users and mobile phone subscribers per 100 inhabitants in South Asia, 2013**



Source: International Telecommunications Union

TRENDS IN R&D

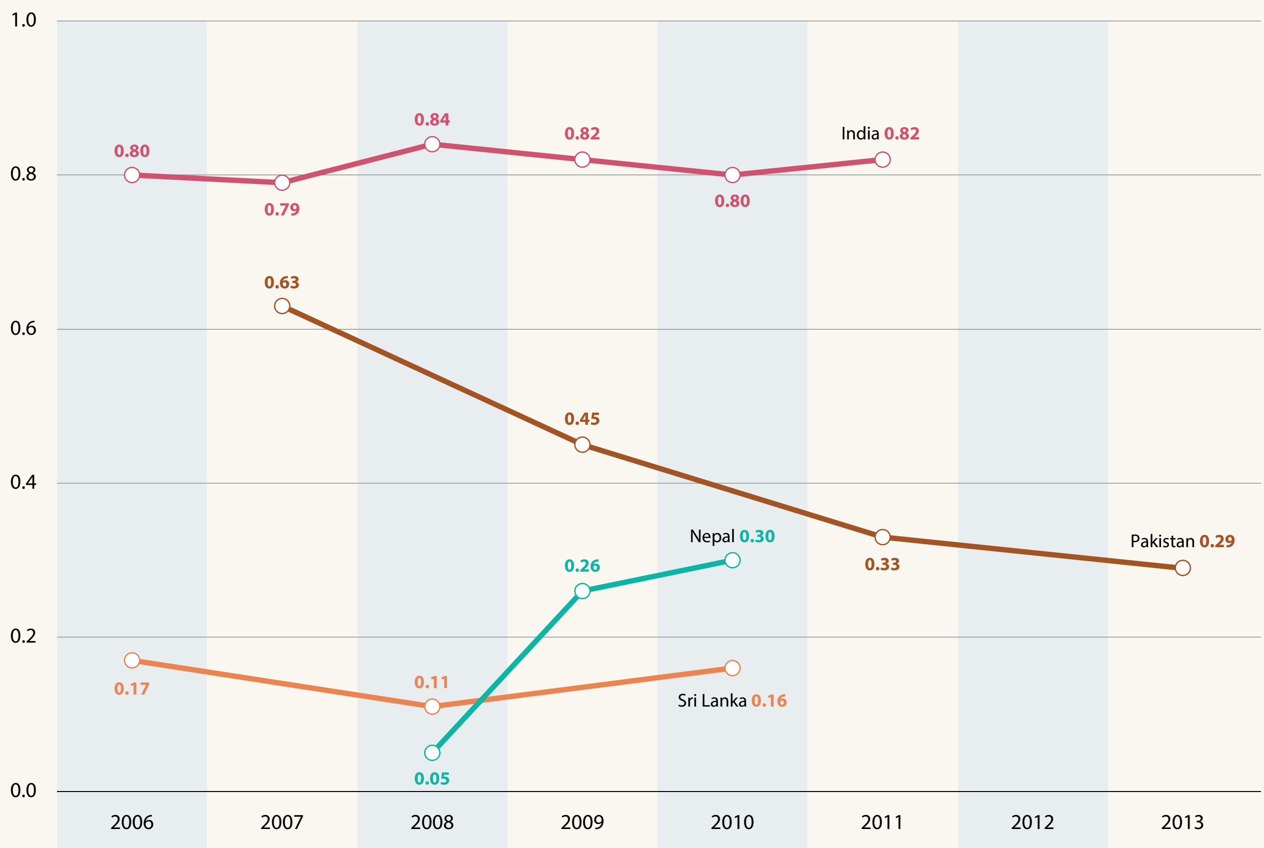
A modest R&D effort

By international standards, countries in South Asia spend modest amounts on research and development (R&D). Gross domestic expenditure on R&D (GERD) even dropped in Pakistan between 2007 and 2013 from 0.63% to 0.29% of GDP, although the government did not survey the business enterprise sector (Figure 21.5); this trend has been accompanied by an attempt in Pakistan to decentralize higher education and research spending, devolving it to the provincial level. In Sri Lanka, investment remains stable but low, at 0.16% of GDP in 2010, less than the R&D intensity of Nepal (0.30%), which has improved markedly since 2008, and far below that of India (0.82%). This lack of investment correlates with low researcher intensity and limited integration in global research networks.

As shown in Figure 21.6, the majority of countries in the region lie within a narrow range in terms of their ranking for private-sector expenditure on R&D in the World Economic Forum's Global Competitiveness Index, at between 2.28 and 3.34 in 2014, with Sri Lanka recording the best performance. Since 2010, only Nepal has shown a marginal improvement in private-sector spending on R&D. With the exception of Bangladesh and Nepal, South Asia's private sector is more implicated in R&D than in sub-Saharan Africa (average of 2.66) but less so than in emerging and developing countries, in general (3.06 on average), the notable exception being Sri Lanka. Above all, the countries of the Organisation for Economic Co-operation and Development (OECD) are streets ahead of South Asia, with an average score of 4.06, reflecting the higher level of market development in industrialized economies.

Overall, R&D spending in South Asia has not kept pace with economic growth over the past five years. The fact that both the public and private sectors exhibit similar trends is indicative of the broader lack of capacity and failure to prioritize research. This is also attributable to the relatively low levels of disposable income and commercial market development, as well as the limited margin for manoeuvre in government budgets when it comes to allocating funds to R&D.

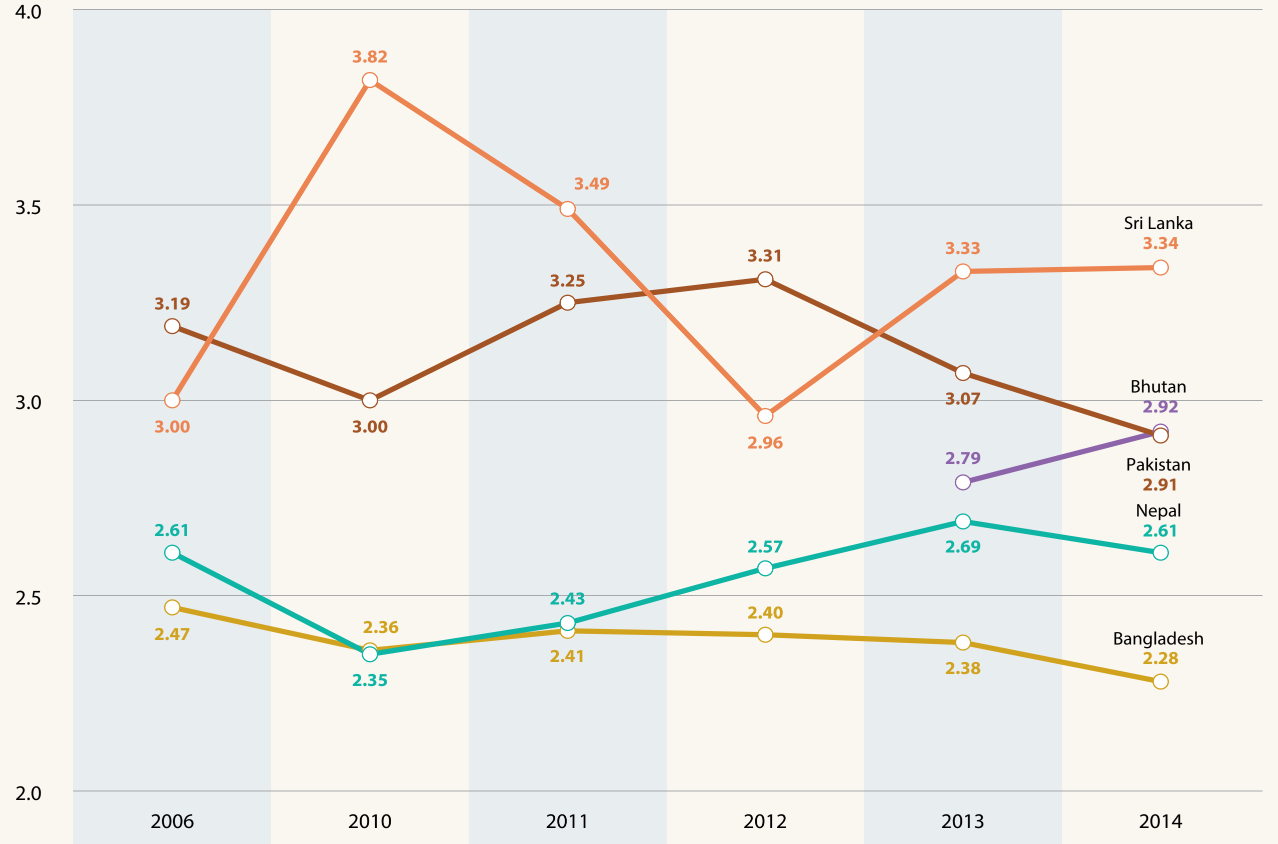
Figure 21.5: **GERD/GDP ratio in South Asia, 2006–2013**



Note: Data are unavailable for Bhutan, Bangladesh and the Maldives. The data for Nepal are partial and relate to Government R&D budget instead of R&D expenditure; those for Pakistan exclude the business enterprise sector.

Source: UNESCO Institute for Statistics, June 2015

Figure 21.6: **South Asian ranking for private-sector expenditure on R&D, 2010–2014**



Source: World Economic Forum Global Competitiveness Index, accessed December 2014

Nepal catching up to Sri Lanka for researcher density

With recent data on researchers being available only for Nepal, Pakistan and Sri Lanka, it would be hazardous to draw any conclusions for the region as a whole. However, the available data do reveal some interesting trends. Nepal is catching up to Sri Lanka in terms of researcher density but the share of women in the Nepalese research pool is low and, in 2010, was almost half that in 2002 (Figure 21.7). Sri Lanka has the greatest share of women researchers but their participation rate is lower than before. Pakistan has the greatest researcher density of the three but also the lowest density of technicians; moreover, neither indicator has progressed much since 2007.

R&D output up, despite low investment

In terms of patent applications, all countries appear to have made progress in the past five years (Table 21.3). India continues to dominate, thanks in part to the dynamism of foreign multinationals specializing in ICTs (see Chapter 22), but Pakistan and Sri Lanka have also made confident strides. Interestingly, statistics from the World Intellectual Property Organization (WIPO) for 2013 reveal that more non-resident Bangladeshis, Indians and Pakistanis are filing patent applications than before. This suggests the presence of strong diaspora communities in developed countries and/or of foreign multinationals in these countries.

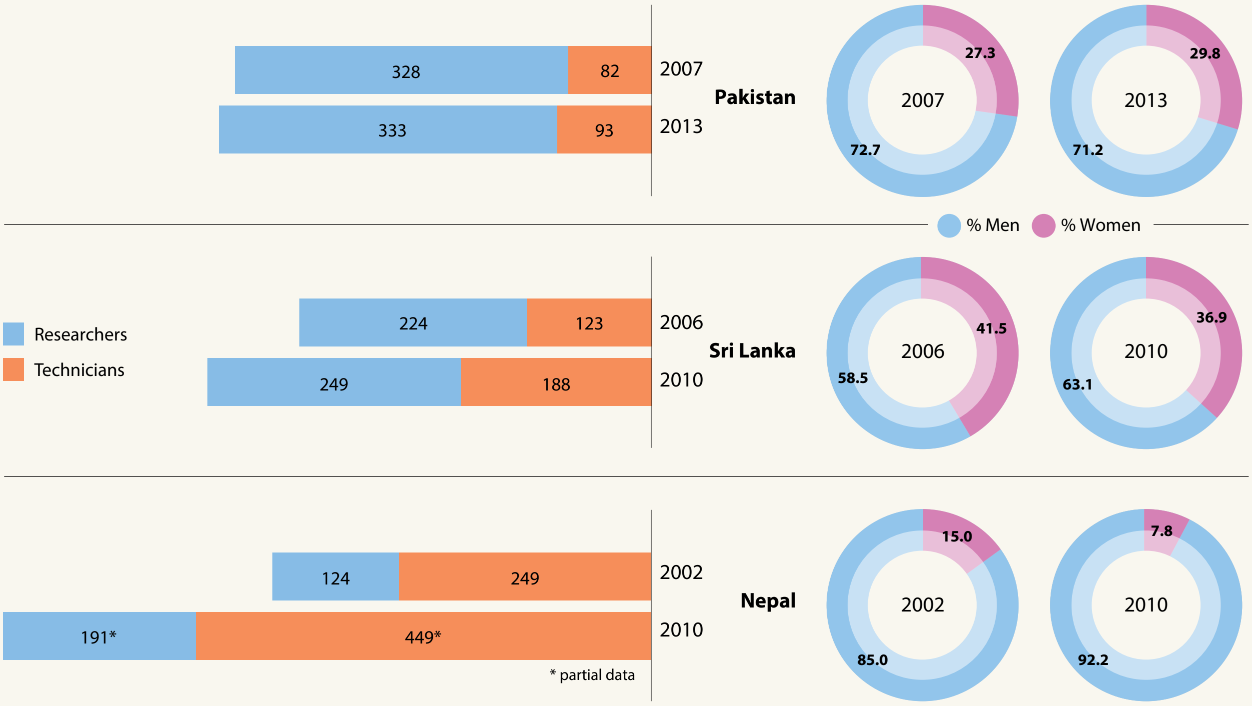
High-tech exports remain insignificant, with only India, Nepal, Pakistan and Sri Lanka reporting measureable figures: 8.1%, 0.3%, 1.9% and 1.0% respectively of their manufactured exports in 2013. However, in recent years, communications- and computer-related exports, including international telecommunications and computer data services, have dominated service exports by Afghanistan, Bangladesh and Pakistan; as for Nepal, it has shown impressive growth in this area of 36% in 2009 and 58% in 2012 as a share of service exports. Whereas Afghanistan and Nepal trade mostly with their South Asian neighbours, the other countries profiled in the present chapter limit their level of imports and exports within the region to about 25% of the total. This is essentially due to the narrow range of exports, weak consumer purchasing power within the region and insufficient regional efforts to foster the innovation needed to meet the unserved demand.

The number of scientific papers from South Asia (including India) registered in the Web of Science rose by 41.8% between 2009 and 2014 (Figure 21.8). The most spectacular progress was observed in Pakistan (87.5%), Bangladesh (58.2%) and Nepal (54.2%). In comparison, Indian publications rose by 37.9% over the same period.

Despite the stagnation in spending on higher education in Pakistan since 2008 (as a share of GDP), the momentum generated by reforms during the first decade of the century has not slowed. Meanwhile, in Nepal, the rapid increase in R&D spending between 2008 and 2010 appears to be reflected in the rise in research output, which accelerated after 2009.

Despite this progress, South Asia's research output remains modest relative to other parts of the world, be it in terms of international patents or publications in peer-reviewed journals. This lower scale of research activity is directly attributable to the lack of measureable R&D input, both from the public and private sectors. The region's academic capacity for teaching and research is also among the lowest in the world.

Figure 21.7: **Researchers (HC) and technicians in South Asia per million inhabitants and by gender, 2007 and 2013 or closest years**



Note: Data for Pakistan exclude the business enterprise sector.

Source: UNESCO Institute for Statistics, June 2015

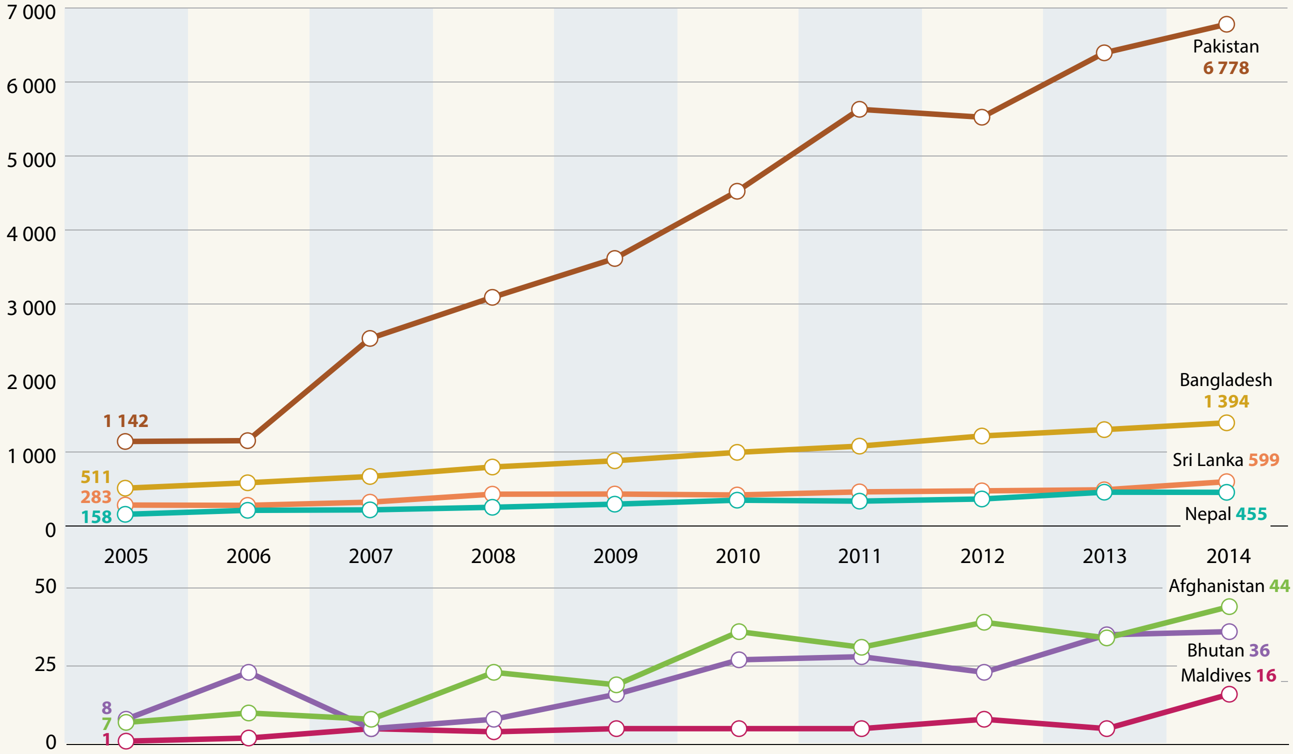
Table 21.3: **Patent applications in South Asia, 2008 and 2013**

	2008			2013		
	Total resident	Resident applications per million inhabitants	Total non-resident	Total resident	Resident applications per million inhabitants	Total non-resident
Bangladesh	29	0.19	270	60	0.39	243
Bhutan	0	0	0	3	3.00	1
India	5 314	4.53	23 626	10 669	8.62	32 362
Nepal	3	0.12	5	18	0.67	12
Pakistan	91	0.55	1 647	151	0.84	783
Sri Lanka	201	10.0	264	328	16.4	188

Source: WIPO Statistics Database, accessed April 2015

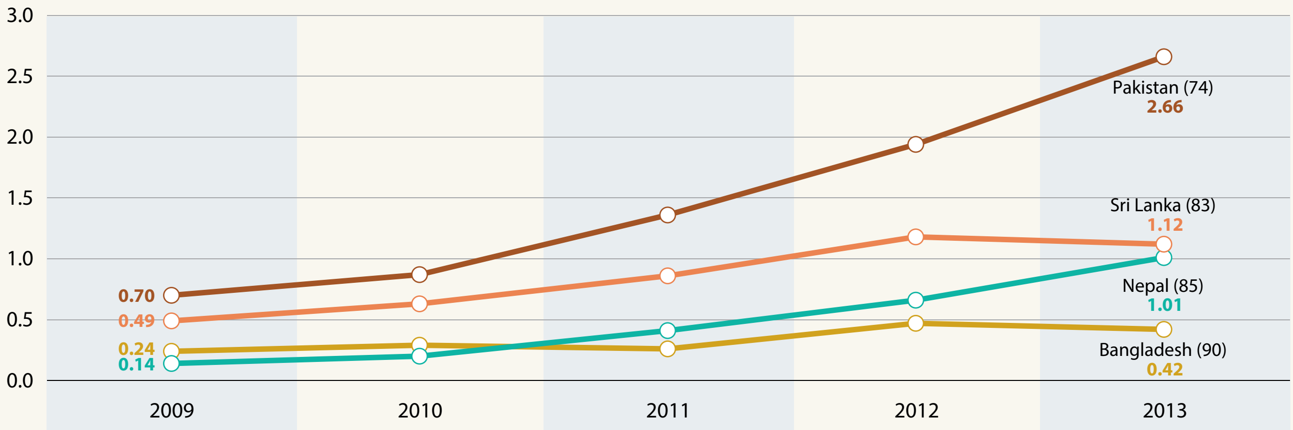
Figure 21.8: **Scientific publication trends in South Asia, 2005–2014**

Strong growth in Bangladesh, Nepal and Pakistan since 2009



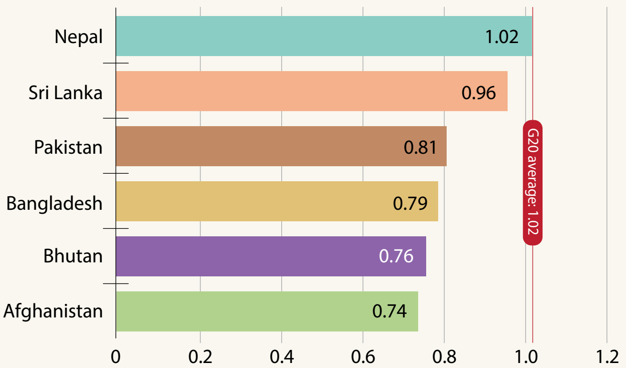
Pakistan produces the most articles related to nanotechnology per million inhabitants

Countries' world rank is shown between brackets

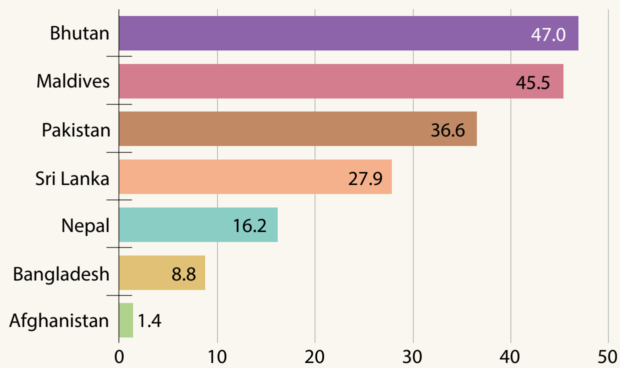


Among high-population countries, Pakistan has the greatest publication intensity

Average citation rate, 2008–2012

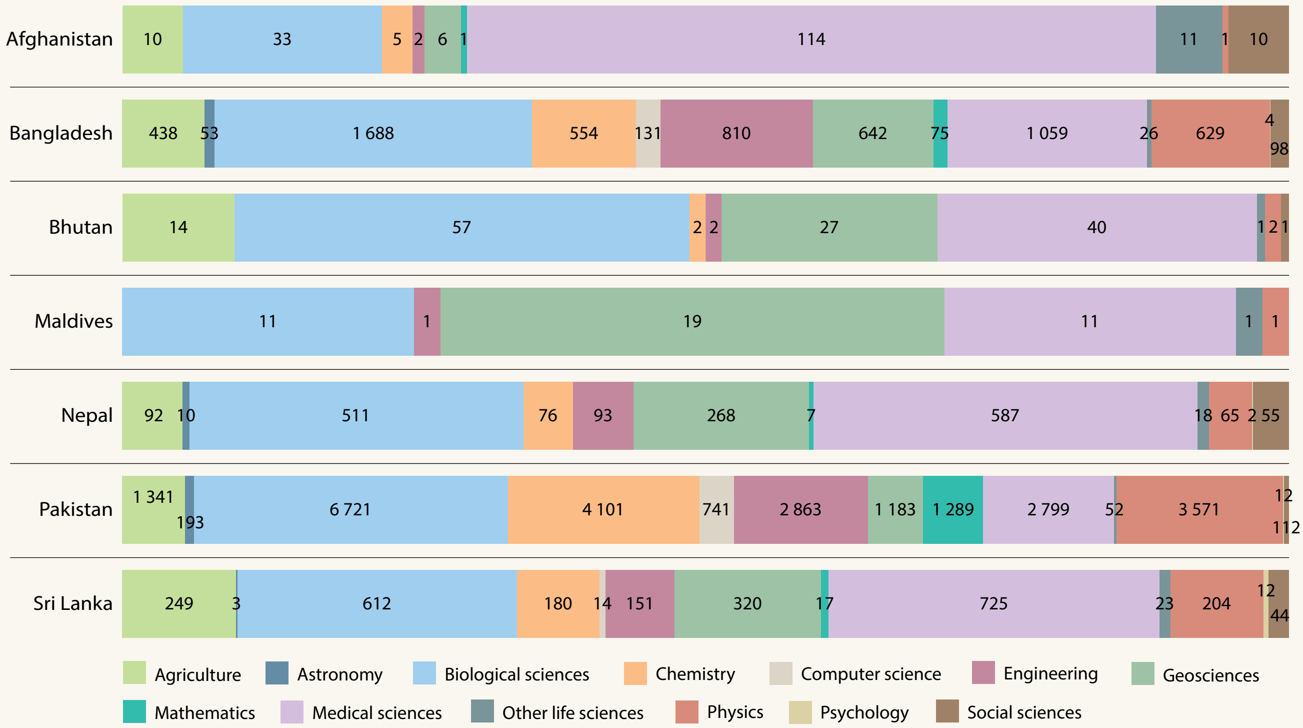


Publications per million inhabitants, 2014



Life sciences dominate in South Asia, Pakistan also specializes in chemistry

Cumulative totals by field, 2008–2014



Note: Unclassified articles are excluded from the totals.

Fellow Asians figure among South Asians' main foreign partners

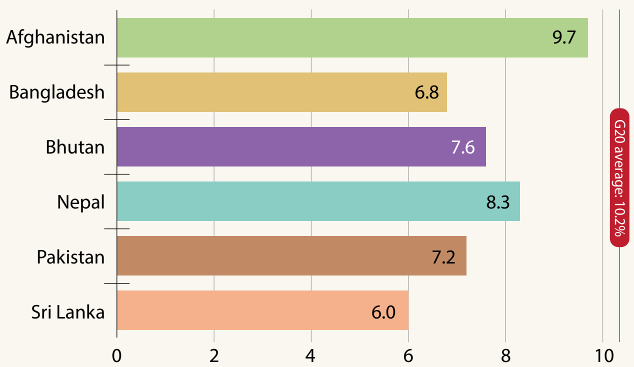
Top five collaborators, 2008–2014 (number of articles)

	1st collaborator	2nd collaborator	3rd collaborator	4th collaborator	5th collaborator
Afghanistan	USA (97)	UK (52)	Pakistan (29)	Egypt/Japan (26)	
Bangladesh	USA (1394)	Japan (1218)	UK (676)	Malaysia (626)	Rep. of Korea (468)
Bhutan	USA (44)	Australia (40)	Thailand (37)	Japan (26)	India (18)
Maldives	India (14)	Italy (11)	USA (8)	Australia (6)	Sweden/Japan/UK (5)
Nepal	USA (486)	India (411)	UK (272)	Japan (256)	Rep. of Korea (181)
Pakistan	USA (3 074)	China (2 463)	UK (2 460)	Saudi Arabia (1 887)	Germany (1 684)
Sri Lanka	UK (548)	USA (516)	Australia (458)	India (332)	Japan (285)

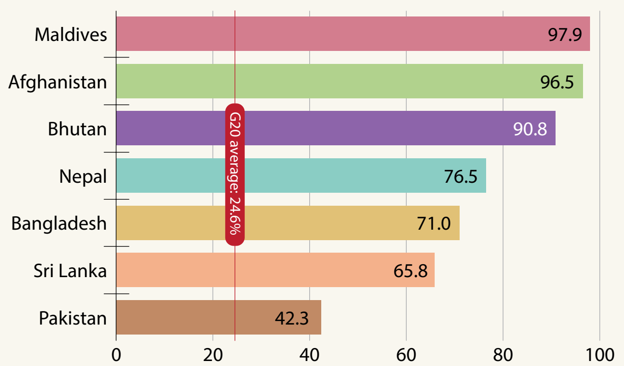
Source: Thomson Reuters' Web of Science, Science Citation Index Expanded, data treatment by Science–Metrix

The majority of articles have foreign partners in all but Pakistan

Share of South Asian papers among 10% most-cited, 2008–2012 (%)



Share of papers with foreign co-authors, 2008–2014 (%)



Source: Thomson Reuters' Web of Science, Science Citation Index Expanded, data treatment by Science–Metrix; for nano-articles: statnano.com, see Figure 15.5

COUNTRY PROFILES

AFGHANISTAN

Rapid gains in girls' education

Afghanistan has one of the lowest literacy rates in the world: about 31% of the adult population. Some 45% of men and 17% of women are literate, with wide variations from one province to another. In 2005, the country committed to achieving universal primary education by 2020. Energetic efforts to achieve gender parity have been rewarded by a steep increase in the net enrolment ratio for girls from just 4% in 1999 to an estimated 87% in 2012. By 2012, there was a net intake of 66% of girls and 89% of boys in primary education; boys could expect to complete 11 years of schooling and girls seven years, according to UNESCO's *Education for All Monitoring Report* (2015).

Infrastructure not keeping pace with student rolls

The two key goals of the *National Higher Education Strategic Plan: 2010–2014* devised by the Afghan Ministry of Higher Education were to improve quality and broaden access to higher education, with an emphasis on gender equity. According to a progress report by the same ministry, the number of women students tripled between 2008 and 2014, yet women still represent just one in five students (Figure 21.9). Girls still encounter more difficulties than boys in completing their schooling and are penalized by the lack of university dormitories for women (MoHE, 2013).

The Ministry of Higher Education has largely surpassed its target for raising university enrolment, which doubled between 2011 and 2014 (Figure 21.9). A shortfall in funding has prevented the construction of facilities from keeping pace with the rapid rise in student rolls, however. Many facilities also still need upgrading; there were no functioning laboratories for physics students at Kabul University in 2013, for instance (MoHE, 2013). Only 15% of the US$ 564 million in funding requested of donors by the ministry has materialized since 2010.[2]

Within its *Higher Education Gender Strategy* (2013), the ministry has developed an action plan to augment the number of women students and faculty (Figure 21.9). A pillar of this plan is the construction of women's dormitories. With help from the US State Department, one was completed in Herat in 2014 and another two are planned for Balkh and Kabul. They should house about 1 200 women in total. The ministry also requested funds from the National Priority Programme budget for the construction of ten additional dormitories for 4 000 women students; six of these were completed in 2013.

2. The main donors are the World Bank, USAID, US State Department, NATO, India, France and Germany.

Part of the growth in university student rolls can be attributed to 'night school', which extends access to workers and young mothers. Having a 'night shift' also makes use of limited space that would otherwise be vacant in the evenings. The night shift is proving increasingly popular, with 16 198 students enrolling in 2014, compared to just 6 616 two years earlier. Women represented 12% (1 952) of those attending evening classes in 2014.

New master's programmes offer more choices

By 2014, the Curriculum Commission had approved the curricular reviews and upgrades for one-third of Afghanistan's public and private faculties. Progress in meeting recruitment goals has also been steady, since staffing is covered by the regular budget allocations (Figure 21.9).

One of the ministry's priorities has been to increase the number of master's programmes (Figure 21.9). This will broaden opportunities for women, in particular, given the difficulties they face in going abroad for master's and PhD training: in the two new master's programmes in education and public administration, half of the students are women. Five of the eight master's degrees granted by Kabul University between 2007 and 2012 were also obtained by women (MoHE, 2013).

Another priority is to increase the share of faculty with a master's degree or PhD. The wider choice of programmes has enabled more faculty to obtain a master's degree but doctoral students still need to study abroad, in order to increase the small pool of PhDs in Afghanistan. The share of master's and PhD-holders has dropped in recent years, as the number of faculty members at Afghan universities has risen; the drop in the share of PhD-holders from 5.2% to 3.8% between 2008 and 2014 was also due to a wave of retirement (Figure 21.9).

Two schemes enable faculty to study abroad. Between 2005 and 2013, 235 faculty members completed their master's degree abroad, thanks to the World Bank's Strengthening Higher Education Programme. In 2013 and 2014, the Ministry of Higher Education's development budget funded the study abroad of 884 faculty working towards their master's degree and 37 faculty enrolled in doctoral programmes.

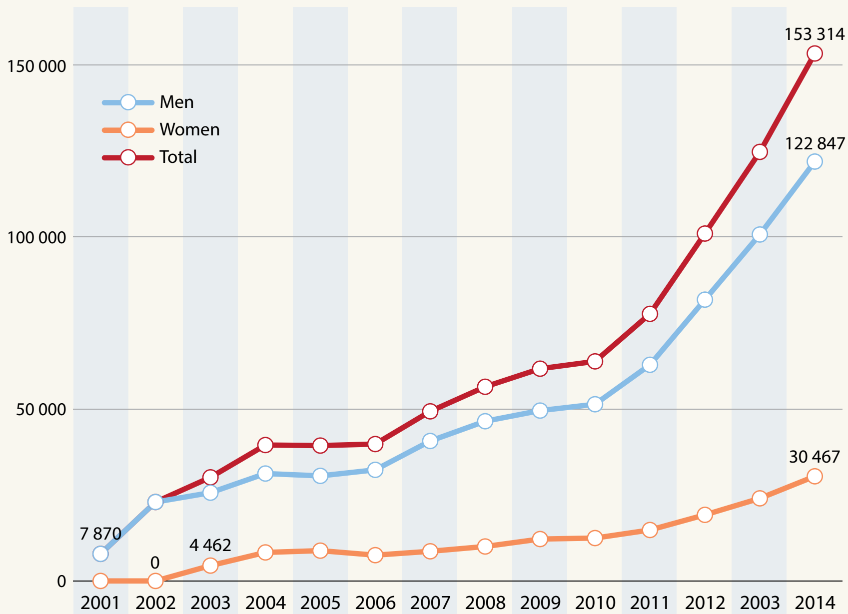
Grants to revive the research culture

In order to revive Afghanistan's research culture, research units have been installed at 12 universities[3] as part of the World Bank's Higher Education Systems Improvement Project. In parallel, the Ministry of Higher Education developed a digital library in 2011 and 2012 which provides

3. Kabul University, Kabul Polytechnic University, Herat University, Nangarhar University, Balkh University, Kandahar University, Kabul Education University, Albiruni University, Khost University, Takhar University, Bamyan University and Jawzjan University.

Figure 21.9: **Afghanistan's ambitious university reform**

Enrolment in public universities doubled between 2011 and 2014



63 837
Afghan university student population in 2010

153 314
Afghan university student population in 2014

20.5%
Share of women university students in 2010

19.9%
Share of women university students in 2014

Afghanistan is making headway towards its higher education targets

	Target	Current situation
National Higher Education Strategic Plan: 2010–2014 (published 2010)	US$ 564 million to be obtained in funding to implement the plan	15% (US$ 84.13 million) received from donors as of 2014
	The number of students at public universities to double to 115 000 by 2015	153 314 students were enrolled in 2014 (target reached)
	Higher education to represent 20% of the education budget by 2015, equivalent to US$ 800 per student in 2014 (corresponding to a budget of US$ 80 million for 2012) and US$ 1 000 by 2015.	The approved budget for 2012 for higher education was US$ 47.1 million, equivalent to US$ 471 per student
	The number of faculty members in public universities to increase by 84% by 2015 to 4 372 and the number of staff by 25% to 4 375	By October 2014, there were 5 006 faculty members; by 2012, there were 4 810 other university staff (target reached)
	The number of master's programmes in Afghanistan to rise	A total of 8 master's programmes were available in 2013 and 25 in 2014 (target reached)
	The share of faculty with a master's degree (31% in 2008) or PhD (5.2% in 2008) to rise	The share of master's degrees and PhDs has dropped slightly, owing to the steep increase in the number of faculty and a wave of retirement among PhD-holders: by October 2014, 1 480 faculty held a master's degree (29.6%) and 192 a PhD (3.8%); 625 faculty members were studying for a master's degree and were expected to graduate by December 2015
	The Ministry of Higher Education to establish Commission on Curriculum	Commission established (target reached); by 2014, it had helped 36% of public faculties (66 out of 182) and 38% of private faculties (110 out of 288) to review and upgrade their curricula
Higher Education Gender Strategy (published 2013)	Women to represent 25% of students by 2014 and 30% by 2015	In 2014, women represented 19.9% of students
	13 women's dormitories to be built	By 2014, seven had been completed
	The number of Afghan women with a master's degree to rise	As of October 2014, 117 women (23% of the total) were pursuing a master's degree in Afghan universities, compared to 508 men
	The proportion of women faculty members to rise to 20% by 2015	By October 2014, 690 faculty members were women (14%), out of a total of 5 006
	The number of women faculty with a master's and PhD degree to rise	By October 2014, 203 women faculty held a master's degree (compared to 1 277 men) and 10 women a PhD

Source: MoHE (2013); MoHE communication in October 2014 all faculty, students and staff with access to about 9 000 academic journals and 7 000 e-books (MoHE, 2013). Participation in research is now a requirement for the promotion of faculty at every level. In the first round of competitive bidding in 2012, research grants were approved for projects proposed by faculty members from Kabul University, Bamyan University and Kabul Education University. Projects concerned the use of IT in learning and research; challenges of the new middle school mathematics curriculum; the effect of automobile pollution on grapevines; integrated management of nutrients in wheat varieties; traditional ways of blending concrete; and the effect of different methods of collecting sperm from bulls (MoHE, 2013).

The research committee established at each of the 12 universities approved 9 research proposals in 2013 and a further 12 in 2014. The ministry is currently working with the Asian Institute of Technology in Thailand to develop joint educational programmes. As part of this collaboration, 12 university faculty members were seconded to the institute in 2014. Work began on drafting a national research policy the same year (MoHE, 2013).

Financial autonomy for universities?

A major goal of the Ministry of Higher Education is to grant some financial autonomy to universities, which are currently not entitled to charge tuition fees or keep any income. The ministry cites a World Bank study from 2005 of Pakistan, which repealed similar restrictive legislation about a decade ago. 'Now, Pakistani universities, on average, earn 49% of their budget (with some as high as 60%) from income they raise and gifts,' observes the ministry (MoHE, 2013).

The aim of the reform is to foster entrepreneurship, university–industry ties and the universities' capacity to provide services. The ministry has prepared a proposal which would allow higher education institutions to keep funds that they earn from entrepreneurial activities, such as drugs analysis done by the Faculty of Pharmacy at Kabul University for the Ministry of Public Health. They would also be able to keep income from night courses and donations from benefactors and alumni. In addition, they would be entitled to set up foundations which could accumulate funds for major projects (MoHE, 2013).

The ministry's position was vindicated by the outcome of a pilot project implemented in 2012 which gave universities in Kabul greater authority over procurement and expenditure below a certain financial threshold. The ministry's plans have been put on hold, however, by the failure of parliament to pass the Higher Education Law, which was approved by the Education Committee in 2012.

BANGLADESH

Great strides in education

The *Bangladesh Education Sector Review 2013* commissioned by the World Bank recognizes significant achievements in primary education since 2010. Net enrolment rates have risen steadily, attaining 97.3% in 2013. Over the same period, the completion rate at primary level rose from 60.2% to 78.6%. Gender parity at both primary and secondary levels has been achieved well ahead of the MDG target set for 2015. The percentage of girls attending school has even surpassed that of boys in recent years.

The quality of education has also improved: according to the Bangladesh Bureau of Educational Information and Statistics, class sizes in secondary schools reportedly shrank from 72 to 44 pupils per class between 2010 and 2013. Repetition rates at primary school level dropped from 12.6% to 6.9% over the same period, with a parallel improvement in the pass rate for the Secondary School Certificate examination and the closing of the gender gap for this indicator. By mid-2014, over 9 000 primary school classrooms had been built or rehabilitated, with the installation of water and sanitary facilities.

Among the drivers of this positive change, the *Education for All 2015 National Review* identifies the conditional cash transfer to children from poor families at primary level and to rural girls at secondary level; the use of ICTs in education; and the distribution of free textbooks to schools, which can also be downloaded free of charge from the government's e-book website.[4]

Among the remaining challenges identified by the *Education Sector Review* (2013), about five million children are still not attending school and the rate of progression from primary to secondary school (60.6% in 2013) has not improved. The review estimates that education plans should target the hardest-to-reach populations. It also pinpoints the need for a substantial rise in budgetary allocations to secondary and higher education. In 2009, the last year for which data are available, just 13.5% of the education budget went to higher education, representing 0.3% of GDP (Figure 21.3).

Despite low levels of funding, enrolment in bachelor's and master's degrees rose from 1.45 million to 1.84 million between 2009 and 2012, with particularly strong growth in S&T fields. Growth was most impressive in engineering (+68%), where enrolment in PhD programmes almost tripled between 2009 and 2012 (Table 21.2). This augurs well for the government's strategy of fostering industrialization and economic diversification. Some 20% of university students are enrolled in a master's programme, one of the highest ratios in Asia, but only 0.4% enrol in a PhD programme (see Figure 27.5).

4. See: www.ebook.gov.bd

ICTs at heart of education policies

After several unsuccessful attempts, the first formal *National Education Policy* was adopted in 2010. Key strategies include providing one year of pre-primary schooling for all children; extending compulsory primary education from Grade 5 to Grade 8 by 2018; expanding vocational/technical training and curricula; making all pupils ICT-literate by the completion of primary school; and updating the syllabuses of higher education to meet international standards.

Both the *National Education Policy* and *National Information and Communication Policy* (2009) underscore the importance of using ICTs in education. For instance, the *National Education Policy* makes ICTs a compulsory subject of vocational and technical education curricula; universities are to be equipped with computers and relevant curricula; and training facilities specializing in ICTs are to be developed for teachers.

The *Master Plan for ICT in Education* for 2012 –2021 sets out to generalize the use of ICTs in education. ICTs were introduced in 2013 as a compulsory subject for higher secondary school pupils intending to sit public examinations in 2015. According to the Bangladesh Bureau of Educational Information and Statistics, the share of secondary schools with computer facilities rose from 59% to 79% between 2010 and 2013 and the percentage of secondary schools with internet shot up from 18% to 63%.

Science and ICTs for middle-income status by 2021

The *Perspective Plan of Bangladesh to 2021* was finalized in 2012 to operationalize the country's blueprint for becoming a middle-income economy by 2021, *Vision 2021*; one thrust of the *Perspective Plan* is to improve the quality of education, with an emphasis on science and technology. Curricula are to be upgraded and the teaching of mathematics, science and information technology encouraged. 'An innovative people will be the backbone of the envisioned society in 2021,' observes the *Plan*, thanks to 'a strong learning system from pre-primary to university levels and the application of research and STI.' Innovation is to be promoted in education and at work. Vast efforts will be made to develop IT through the Digital Bangladesh programme, one of the pillars of *Vision 2021*, in order to foster a 'creative' population (Planning Commission, 2012).

In order to provide the necessary impetus to achieve a Digital Bangladesh by 2021, the Ministry of Science and Information and Communication Technology has been divided into two separate ministries. In its medium-term strategy for 2013–2017, the new Ministry of Information and Communication Technology evokes the development of a high-tech park, an IT village and a software technology park. To this end, the Bangladesh High-tech Authority was created in 2010 by act of parliament. The ministry is currently revising the *National Information and Communication Policy* (2009) and the Copyright Act (2000) to ensure that the rights of local software designers are protected.

The country's first *Science and Technology Policy* was adopted in 1986. It was revised between 2009 and 2011 and is currently under revision once more, in order to ensure that it contributes effectively to realizing the goals of *Vision 2021* (Hossain *et al.,* 2012). Some key targets of *Vision 2021* are to (Planning Commission, 2012):

- establish more institutes of higher learning in science and technology;
- raise GERD 'significantly' from the current level of 0.6% of GDP;
- increase productivity in all spheres of the economy, including micro-enterprises and small and medium-sized enterprises (SMEs);
- establish a National Technology Transfer Office (Box 21.3);

Box 21.3: Quality higher education for Bangladesh

The Higher Education Quality Enhancement Project (2009–2018) funded by the World Bank aims to improve the quality and relevance of the teaching and research environment in Bangladesh by encouraging both innovation and accountability within universities and by enhancing the technical and institutional capacity of the higher education sector.

The mid-term project review reported satisfactory progress in 2014. This included connecting 30 public and private universities to the Bangladesh Research and Education Network and continuous funding allocated on the basis of the performance of academic research projects which had already received funding.

This project is supported by a competitive funding mechanism known as the Academic Innovation Fund (AIF). AIF has clear selection criteria and allocates resources through four competitive funding streams: improvement of teaching and learning and enhancement of research capabilities; university-wide innovation, including the establishment of a National Technology Transfer Office; and collaborative research with industry. In 2014, 135 sub-projects were awarded AIF grants. Earlier projects have also reported satisfactory progress.

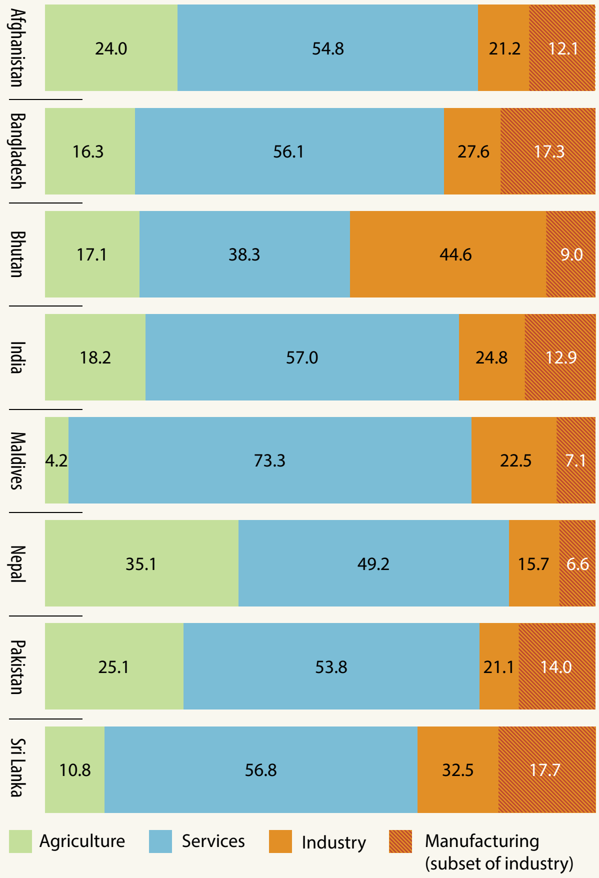
Source: World Bank

- attain self-sufficiency in food production;
- reduce the proportion of people employed in agriculture from 48% to 30% of the labour force;
- raise the contribution of manufacturing to about 27% of GDP and that of industry to about 37% of GDP (Figure 21.10);
- make ICT education compulsory at secondary level by 2013 and at primary level by 2021;
- increase teledensity to 70% by 2015 and 90% by 2021.

The Ministry of Science and Technology describes its current mission as being to:

- expand peaceful use of nuclear energy through the establishment of an atomic power plant and centres of nuclear medicine;
- foster research on biotechnology and develop related human resources;
- develop environment-friendly, sustainable technology for the poor through R&D, such as arsenic-free water, renewable energy and energy-saving cookers;
- develop infrastructure for conducting oceanographic research to enable use of the vast resources of the Bay of Bengal;
- enable the Scientific Documentation Centre to furnish relevant S&T and industrial data to policy-makers and decision-makers; and
- inculcate a scientific attitude in the general public and create interest in astronomy through entertainment.

Figure 21.10: **GDP per economic sector in South Asia, 2013**



Source: World Bank's World Development Indicators, April 2015

Box 21.4: Agricultural technology to boost productivity in Bangladesh

The *Perspective Plan of Bangladesh to 2021* observes that 'flood-resistant crops are a must for the country with chronic floods, little arable land and a rapidly growing population' (1.2% annual growth in 2014). It also acknowledges that, for Bangladesh to become a middle-income country by 2021, industrial expansion must go hand-in-hand with more productive agriculture.

The National Agricultural Technology Project funded by the World Bank (2008–2014) set out to improve yields through research and technology transfer. The World Bank funded the research grants awarded by the government-sponsored Krishi Gobeshana Foundation (Agricultural Research Foundation), which had been set up in 2007. Some of these research projects developed the genotypes of spices, rice and tomato for release by the National Seed Board. Research focused on promoting climate-smart agriculture and agro-ecological approaches to farming in demanding ecosystems, such as floodplains and saline soils. By 2014, the project had clocked up the following achievements:

- 47 demonstrated new technologies had been adopted by 1.31 million farmers;
- 200 applied research projects had been funded;
- Scholarships had been awarded to 108 male and female scientists to pursue higher studies in agriculture;
- 732 farmers information and advisory centres had been established;
- 400 000 farmers had been mobilized into over 20 000 common interest groups linked to markets; and
- 34 improved post-harvest technologies and management practices had been adopted by over 16 000 farmers.

Source: World Bank; Planning Commission (2012)

Revamping industry

Although Bangladesh's economy is based predominantly on agriculture (16% of GDP in 2013), industry contributes more to the economy (28% of GDP), largely through manufacturing (Figure 21.10). The *National Industrial Policy* (2010) sets out to develop labour-intensive industries. By 2021, the proportion of workers employed in industry is expected to double to 25%. The policy identifies 32 sectors with high-growth potential. These include established export industries such as the ready-made garment sector, emerging export industries such as pharmaceutical products and SMEs.

The *National Industrial Policy* also recommends establishing additional economic zones, industrial and high-tech parks and private export processing zones to drive rapid industrial development. Between 2010 and 2013, industrial output already grew from 7.6% to 9.0%. Exports remain largely dependent on the ready-made garment sector, which contributed 68% of all exports in 2011–2012, but other emerging sectors are growing, including shipbuilding and the life sciences. This industrialization policy is in line with the current Sixth *Five-year Plan* (2011–2015), which sees industrialization as a means of reducing poverty and accelerating economic growth.

Three months after the Rana Plaza tragedy in April 2013, in which more than 1 100 mainly female workers in the garment industry perished when a multi-storey factory collapsed, the International Labour Organization, European Commission and the Governments of Bangladesh and the USA signed the Sustainability Compact agreement. This agreement set out to improve labour, health and safety conditions for workers and to encourage responsible behaviour by businesses in the Bangladeshi ready-made garment industry.

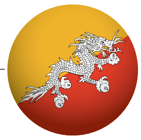
The government has since amended the Labour Act. The amendments include the adoption of a national occupational safety and health policy and standards for safety inspections and the strengthening of laws in support of freedom of association, collective bargaining and occupational safety and health. Safety inspections have been performed in export-oriented garment factories and public factory inspection services have been given more resources. The findings of their ongoing inspections are being made public. For its part, the private sector has put in place an *Accord on Factory and Building Safety in Bangladesh* and an *Alliance for Bangladesh Worker Safety* to facilitate factory inspections and improve working conditions.

Poor infrastructure a deterrent for investors

According to the *World Investment Report 2014*, Bangladesh was one of the top five host countries for FDI in South Asia in 2012 and 2013. FDI net inflows nearly doubled from US$ 861 million in 2010 to US$1 501 million in 2013. Although FDI outflows were low, they did increase from US$ 98 million in US$ 130 million over the same period.

However, UNCTAD's *Investment Policy Review* of Bangladesh (2013) observed that, when FDI inflows were analysed relative to population and as a share of GDP, they were consistently lower in Bangladesh than in some more populous countries such as India and China. The FDI stock of Bangladesh was even lower in 2012 than that of smaller countries such as Cambodia and Uganda. The *Investment Policy Review* found that FDI was instrumental in mobile telephony, substantial in power generation and catalytic but not predominant in garments. The study also found that the poor quality of infrastructure was a major deterrent for potential investors. It suggested that better infrastructure and an improved regulatory framework would foster sustainable investment through FDI.

BHUTAN



Happiness in times of social change

The Kingdom of Bhutan's approach to all aspects of national development is guided by its focus on the overarching concept of gross national happiness. This concept is encapsulated in *Bhutan 2020: A Vision for Peace, Prosperity and Happiness,* the country's development blueprint since 1999. *Bhutan 2020* identifies five principal development objectives: human development; culture and heritage; balanced and equitable development; governance; and environmental conservation.

The Bhutanese have the third-highest level of income in South Asia after the Maldives and Sri Lanka. Per-capita GDP rose steadily between 2010 and 2013 (Figure 21.1). Over the past decade, the traditional, mainly agricultural economy has become more industrialized (Figure 21.10). As the contribution from other sectors has risen, the role of agriculture has declined.

Traditionally, Bhutanese women have held a relatively elevated position in society; they tend to have greater property rights than elsewhere in South Asia, with women rather than men inheriting property in some areas. Industrial development over the past decade appears to have had a negative impact on the traditional place of women in society and their participation in the labour force. The employment gap had been narrowing since 2010 but started widening again in 2013, by which time 72% of men were in gainful employment, compared to 59% of women, according to the *National Labour Force Survey Report (2013).* The unemployment rate nevertheless remains low, at just 2.1% of the population in 2012.

A focus on the green economy and IT

Bhutan's private sector has thus far played a limited role in the economy. The government plans to change this by improving the investment climate through policy and institutional reform and by developing the IT sector, in particular. In 2010, the government revised its *Foreign Direct Investment Policy* (dating from 2002) to bring it into line with its *Economic Development Policy* adopted the same year.

The *Foreign Direct Investment Policy* (2010) identifies the following priority areas for FDI:

- Development of a green and sustainable economy;
- Promotion of socially responsible and ecologically sound industries;
- Promotion of cultural and spiritually sensitive industries;
- Investment in services which promote Brand Bhutan; and
- Creation of a knowledge society.

The policy identifies the following sectors and sub-sectors as being priority areas for investment that merit fast-track approval, among others:

- *Agro-based production*: organic farming; biotechnology, agro-processing, health food, etc.;
- *Energy*: hydropower, solar and wind energy;
- *Manufacturing*: electronics, electrical, computer hardware and building materials.

In 2010, the government published its *Telecommunications and Broadband Policy*. The policy announces the adoption of a *Human Resource Development Plan* to help the ICT sector grow. It also foresees collaboration with the university sector to bridge the gap between curricula and the needs of the IT sector. A revised version of the policy was published in 2014 to reflect the dynamism of this rapidly evolving sector.

Bhutan's first IT park

The Private Sector Development Project (2007–2013) funded by the World Bank is also helping to develop the IT industry. It has three thrusts: fostering the development of enterprises in the IT services sector; enhancing related skills; and improving access to finance. The project has spawned the first IT park in Bhutan, Thimphu TechPark, which was commissioned in May 2012. This is an unprecedented public–private partnership for infrastructure development in Bhutan. The Bhutan Innovation and Technology Centre, which houses Bhutan's first business incubator, has since been established at Thimpu Tech Park.[5]

Industrialization highlights skills mismatch

Illiteracy has long been an issue in Bhutan. In 2010, 53.6% of the labour force was illiterate, 55% of whom were women. Overall illiteracy had declined to 46% by 2013 but remains extremely high. Adding to this picture, only 3% of employees hold a university degree.

In 2012, skilled agricultural and fisheries workers represented 62% of the labour force, compared to only 5% in manufacturing and 2% in mining and quarrying. The agricultural sector, with its inherent bias towards entrepreneurial self-employment, offers untapped potential for developing more value-added products and economic diversification. Appropriate skills training and vocational education will be necessary to nurture the country's industrial development.

The Bhutanese government's eleventh *Five-year Plan* (2013–2018) acknowledges the current shortage of skills in highly specialized professions and the mismatch between curricula and the skills required by industry. It also highlights the challenge posed by the limited resources for developing school infrastructure and the low interest in teaching as a profession: nearly one in ten (9%) teachers was an expatriate in 2010, although this share had dropped to 5% by 2014.

Unlike in other South Asian countries, there are no major gender inequality issues in the Bhutanese education system; primary school enrolment of girls is even higher than that of boys in many urban areas. Net primary school enrolment had reached 95% by 2014, thanks to the development of the secular school system, which has provided pupils living in remote areas with access to education. The government also aims to use ICTs to improve the quality of education (Box 21.5).

Although 99% of children acceded to secondary level education in 2014, three out of four later dropped out (73%). The *Annual Education Statistics Report* (2014) suggests that

5. See:www.thimphutechpark.com/bitc

Box 21.5: Using ICTs to foster collaborative learning in Bhutan

Launched in March 2014, the i-school project in Bhutan is a joint initiative of the Ministry of Education, Bhutan Telecom Limited, Ericsson and the Indian government. The project strives to give children quality education through the use of mobile broadband, cloud computing and the like. The collaborative learning and teaching made possible through this project is based on connectivity to other schools across the country and around the world.

Six schools are participating in the first 12-month pilot phase of the project. Two are located in Thimphu, one in Punakha, one in Wangduephodrang, one in P/Ling and another in Samtse.

Source: compiled by authors

many may be opting for vocational training at this stage of their education. The *National Human Resource Development Policy* (2010) announced that vocational education would be introduced in schools from Grades 6 to 10 and that public–private partnerships would be put in place to improve the quality of training at vocational and technical institutes.

A national council proposed to frame research

The *Tertiary Education Policy* (2010) fixed the target of raising university enrolment from 19% to 33% of 19 year-olds by 2017. The policy observed that mechanisms needed putting in place to measure the level of research activity in Bhutan and recommended an initial scoping exercise. The policy identified the following challenges for research:

- National priorities for research need to be established and a system for determining such a strategy needs to be put in place. Different organizations undertake research but it is not based on an agreed understanding of national priorities.
- Research needs to be encouraged through funding, direction, career structures and access to networks of other researchers. It is also crucial to establish easy connections between research centres with government and industry. Funding could be of two types: seed funds to develop a research culture and more substantial funds to encourage research that attempts to address national problems.
- Facilities, including laboratories and libraries with up-to-date information are needed for research. Currently, there is no government organization responsible for overseeing the interaction between all of the actors within the research and innovation system.

To overcome these shortcomings, the policy stated that a National Council for Research and Innovation would be established. As of 2015, this was not the case.

REPUBLIC OF MALDIVES

Special circumstances call for sustainable solutions

The Republic of Maldives remains heavily reliant on fossil fuels, despite the obvious advantages of local energy generation for the archipelago. A number of initiatives have been taken to promote the uptake of solar and wind–diesel hybrid systems for electricity generation, which are financially feasible (Van Alphen *et al.,* 2008). A study by the Republic of Maldives (2007a) identified a number of constraints, including deficient regulatory frameworks which weaken public–private partnerships and limited technical and managerial capacities in energy transmission and distribution. Similar conclusions can be drawn for the transportation sector, which is fast expanding in the islands due to tourism (Republic of Maldives, 2007b), or the sustainability of the capital, Malé, considered one of the world's most crowded metropolises.

Signs of a greater focus on science

The Maldives has had a tertiary learning institution since 1973 in the form of an Allied Health Services Training Centre. First transformed into the Maldives College of Higher Education in 1999 then into the Maldives National University in February 2011, it remains the country's only tertiary public degree-granting institution. In 2014, the university inaugurated its Faculty of Science, with the introduction of degree programmes in general sciences, environmental science, mathematics and information technology. In addition, postgraduate programmes on offer include a Master of Science in Computing and a Master of Science in Environmental Management. The university also has its own journal, the *Maldives National Journal of Research*, but the focus appears to be on pedagogy rather than the university's own research.

Research output remains modest, with fewer than five articles being published each year (Figure 21.8). The fact that nearly all publications in the past decade involved international collaboration nevertheless bodes well for the development of endogenous science.

A commitment to education spending

The Maldives devoted 5.9% of GDP to education in 2012, the highest ratio in the region. It faces a number of challenges in developing its human capital that have been compounded by the political turmoil since 2012. Other challenges include the large share of expatriate teachers and the mismatch between curricula and the skills employers need.

Although the Maldives had achieved universal net primary enrolment by the early 2000s, this had fallen back to 94% by 2013. Nine out of ten pupils went on to secondary school (92.3%) in 2014 but only 24% stayed on at the higher secondary level. There are more girls than boys at the primary and lower secondary levels but boys overtake girls at the higher secondary level.

The Ministry of Education is eager to improve the quality of education. Between 2011 and 2014, UNESCO implemented a project in the Maldives for Capacity-building in Science Education, with financial support from Japan and the involvement of the Centre for Environment Education in India. The project developed teaching guides and prepared modules and hands-on activity kits to foster creative thinking and the scientific method. In-service teacher training was also organized for students at the Maldives National University.

The Ministry of Education and Ministry of Human Resources, Youth and Sport began implementing a one-year Hunaru ('skills') Project for vocational and technical training in 2013. The aim is to train 8 500 young people in 56 occupational fields, with the government paying a fixed amount per student. Both public and private institutions can apply to run these courses.

The government is intensifying public–private partnerships by offering land and other incentives to private companies to set up institutions offering higher education in selected locations. One such partnership was under way on Lamu Atoll in 2014, where the Indian company Tata has agreed to set up a medical college and to develop a regional hospital.

NEPAL

Moderate growth, falling poverty

Despite its prolonged political transition since the end of the civil war in 2006, Nepal has registered a moderate rate of growth averaging 4.5% over 2008–2013, as compared to the low-income country average of 5.8%. Nepal was hardly affected by the global financial crisis of 2008–2009, as it remains poorly integrated in global markets. Exports of goods and services as a share of GDP nevertheless fell from 23% to 11% between 2000 and 2013. Contrary to what one would expect from a country at Nepal's stage of development, the share of manufacturing has also gone down slightly in the five years to 2013, to just 6.6% of GDP (Figure 21.10).

The country is on track to reach a number of MDGs, particularly those in relation to the eradication of extreme poverty and hunger, health, water and sanitation (ADB, 2013). Nepal will need to do much more, though, to reach the MDGs relating to employment, adult literacy, tertiary education or gender parity in employment, which are more germane to science and technology. The country has some key advantages, notably high remittances from abroad – 20.2% of GDP between 2005 and 2012 – and the country's proximity to high-growth emerging market economies such as China and India. Nepal lacks an effective growth strategy, though, to harness these advantages to accelerated development. The Asian Development Bank's *Macroeconomic Update of Nepal* underlined in February 2015 the deficient investment in R&D and innovation by the private sector as being key constraints to supply capacity and competitiveness.

The government is cognizant of the problem. Nepal has had a specific ministry in charge of science and technology since 1996. The responsibilities of this ministry have been combined with those of the environment since 2005. Partly as a result, the country's modest efforts in science and technology are heavily focused on environmental issues, which is broadly defensible, given Nepal's high vulnerability to natural disasters and climate-related risks. The current *Three-Year Plan* (2014–2016) includes a number of priority areas that are relevant to S&T policies and outcomes (ADB, 2013, Box 1):

- Increasing access to energy, especially a rural electrification programme based on renewable sources (solar, wind, and hybrids) and miniature run-of the river hydropower plants;
- Increasing agricultural productivity; and
- Climate change adaptation and mitigation.

Realizing these goals, while addressing Nepal's competitiveness and growth challenges more broadly, will depend heavily on the uptake of clean and environmentally sound technologies. Successful technology absorption will, in turn, be conditional on the adequate development of local S&T capacities and human resources.

Three new universities since 2010

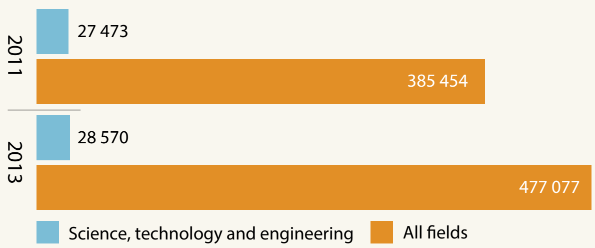
The *UNESCO Science Report 2010* attributed the lack of development in S&T capabilities to the low priority given to education in basic sciences, at the expense of applied fields such as engineering, medicine, agriculture and forestry. Nepal's oldest university, Tribhuvan University (1959) has since been joined by eight other institutions of higher learning, the last three of which were established in 2010: the Mid-western University in Birendranagar, the Far-western University in Kanchanpur and Nepal Agriculture and Forestry University in Rampur, Chitwan.

Despite this development, official statistics suggest that enrolment in S&T fields is not progressing as fast as tertiary enrolment overall. Science and engineering students accounted for 7.1% of the student body in 2011 but only 6.0% two years later (Figure 21.11).

Striking a balance between basic and applied sciences

It is justifiable for a low-income country like Nepal to focus on applied research, provided it has sufficient connectivity to be able to tap into basic scientific knowledge generated elsewhere. At the same time, a greater capability in basic

Figure 21.11: **Students enrolled in higher education in Nepal, 2011 and 2013**



Source: UNESCO Institute for Statistics, June 2015 sciences would help the country to absorb and apply knowledge and inventions produced abroad. The exact balance of policy focus in this area is a difficult call to make in the absence of a more in-depth review of Nepal's innovation constraints and options. Moreover, whereas the *UNESCO Science Report 2010* and national studies (such as NAST, 2010) have advocated a greater focus on basic research in Nepal, some of the country's more recent policy pronouncements establish the priority of learning in applied science and technology over pure science; this is the case, for example, of the declared objectives of the planned Nanotechnology Research Centre (Government of Nepal, 2013a).

A leap forward in Nepal's R&D effort

The *UNESCO Science Report 2010* had also underlined the low level of private sector investment in R&D. Half a decade on, Nepal still does not measure the business sector's R&D effort. However, official statistics suggest a leap in the government budget for R&D since 2008, from 0.05% to 0.30% of GDP in 2010, a greater effort than that of the relatively richer economies of Pakistan and Sri Lanka. Considering that 25% of researchers (by head count) worked in the business sector, higher education or non-profit sector in 2010, total GERD in Nepal is likely to be closer to 0.5% of GDP. Indeed, the data also suggest a 71% increase[6] in the number of researchers between 2002 and 2010 to 5 123 (or 191 per million population), as well as a doubling of technicians over the same period (Figure 21.7).

Potential to attract the diaspora

The *UNESCO Science Report 2010* had noted the low number of PhD students in Nepal and the modest level of scientific production. In 2013, there were still only 14 PhD degrees awarded in Nepal.

At the same time, Nepal has a relatively large tertiary student population abroad, numbering 29 184 in 2012. That year, the Nepalese represented the eighth-largest foreign student population in natural and social sciences and engineering disciplines in the USA[7] and the sixth-largest in Japan, according to the National Science Foundation's *Science & Engineering Indicators, 2014*. Between 2007 and 2013, 569 Nepalese nationals earned PhDs in the USA. Likewise, there are sizeable Nepalese tertiary student communities in Australia, India, the UK and Finland[8]. There is a potential to harness this expatriate talent for the development of Nepal's future S&T potential, provided the right circumstances and momentum can be provided to woo them back home.

6. although there was a break in the data series between 2002 and 2010

7. after China, the Republic of Korea, Saudi Arabia, India, Canada, Viet Nam and Malaysia

8. www.uis.unesco.org/Education/Pages/international-student-flow-viz.aspx

Ambitious plans to 2016

The Nepalese government is confident that the period of the *Twelfth Three-Year Plan* covering 2010–2013 has made a difference. This period has been marked by the start of DNA testing in Nepal, the establishment of a science museum, the expansion of forensic science services, the consolidation of research laboratories and the inception of three-cycle studies (Government of Nepal, 2013b). The government also claims to have minimized brain drain.

In the field of disaster risk reduction, two projects were implemented within the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia. The first sought to develop a flood forecasting system for Nepal (2009–2011) and the second to expand climate risk management through technical assistance. As events so cruelly recalled in April 2015, Nepal does not have an earthquake early warning system which would have given citizens forewarning of about 20 seconds of the impending disaster. Moreover, the number of lives lost in recent floods, despite the existence of a flood warning system, indicates the need for a more integrated solution.

The *Thirteenth Three-Year Plan* covering 2013–2016 goes a step farther by articulating specific objectives to enhance the contribution of science and technology to economic development, including by:

- checking and reversing the brain drain of scientists and technicians;
- encouraging the formation of research and development units within industries;
- harnessing atomic, space, biological and other technologies, as required, for development;
- developing capacities in biological sciences, chemistry and nanotechnologies, in particular to benefit from Nepal's rich biodiversity; and
- mitigating the effects of natural disasters and climate change, through early warning systems and other mechanisms, in part through the use of space technology.

In this context, the Ministry of Science, Technology and Environment plans to set up four technology centres in the near future, namely a National Nuclear Technology Centre, a National Biotechnology Centre, a National Space Technology Centre and a National Nanotechnology Centre. Some of these research areas have obvious relevance for Nepal's sustainable development, such as the use of space-related technologies for environmental surveying and disaster monitoring or weather forecasting. The Nepalese government needs to elaborate further the rationale and context behind other initiatives, such as its plans for nuclear technology development.

PAKISTAN

Plans to boost higher education spending

Since 2010, Pakistan's economy has remained relatively depressed, owing to the uncertain security situation and ongoing political power crisis. More than 55 000 civilians and military personnel have perished in hundreds of major and minor terrorist attacks across major urban centres since 2003.[9] Between 2010 and 2013, Pakistan's annual growth rate averaged 3.1%, compared to 7.2% in India and 6.1% in Bangladesh. The economic impact of the security situation manifests itself in consistently falling investment levels: FDI inflows accounted for 2.0% of GDP in 2005 but only 0.6% in 2013. In addition, tax revenue stood at 11.1% of GDP in 2013, according to the World Bank, one of the lowest rates in the region, limiting the government's ability to invest in human development.

During the 2013–2014 fiscal year, government spending on education stood at merely 1.9% of GDP, just 0.21% of which was earmarked for higher education. Education spending has shrunk each year since peaking at 2.75% of GDP in 2008. As part of Pakistan's effort to create a knowledge economy, *Vision 2025* (2014) has fixed the target of achieving universal primary school enrolment and raising university enrolment from 7% to 12% of the age cohort and the number of new PhDs per year from 7 000 to 25 000 over the next decade. In order to reach these targets, the government has proposed devoting at least 1% of GDP to higher education alone by 2018 (Planning Commission, 2014).

Vision 2025 was developed by the Ministry of Planning, Development and Reform and approved by the National Economic Council in May 2014. It identifies seven pillars for accelerating the pace of economic growth, including through the creation of a knowledge economy:

- Putting people first: developing human and social capital;
- Achieving sustained, indigenous and inclusive growth;
- Governance, institutional reform and modernization of the public sector;
- Energy, water and food security;
- Private sector-led growth and entrepreneurship;
- Developing a competitive knowledge economy through value addition; and
- Modernization of transportation infrastructure and greater regional connectivity.

9. according to the Institute for Conflict Management, South Asia Terrorism Portal; see: www.satp.org/satporgtp/icm/index.html.

Within this vision, the first and sixth pillars are directly relevant to the STI sector, whereas the overall global competitiveness of the country will depend on innovation in certain competitive sectors. Moreover, government-led infrastructure projects being planned as part of this vision include the construction of a highway linking Lahore and Karachi, the Peshawar Northern Bypass, Gawadar Airport and the Gawadar Free Economic Zone.

The government plans to reconfigure the current energy mix to overcome power shortages. About 70% of energy is generated using furnace oil, which is costly and has to be imported. The government plans to convert furnace oil plants to coal and is investing in several renewable energy projects, which are one of the priorities of *Vision 2025*.

Energy is one focus of the new Pakistan–China Economic Corridor Programme. During the Chinese president's April 2015 visit to Pakistan, 51 memoranda of understanding were signed between the two governments for a total of US$ 28 billion, much of it in the form of loans. Key projects within this programme include developing clean coal-based power plants, hydropower and wind power, a joint cotton biotech laboratory to be run by the two ministries of science and technology, mass urban transportation and a wide-ranging partnership between the National University of Modern Languages in Islamabad and Xinjiang Normal University in Urumqi. The programme takes its name from the planned corridor that is to link the Pakistani port of Gwadar on the Sea of Oman to Kashgar in western China near the Pakistani border, through the construction of roads, railway lines and pipelines.

In January 2015, the government announced two policies to facilitate the deployment of solar panels across the country, including the removal of taxes on imports and sales of solar panels. After these taxes were introduced in 2013, the volume of solar panel imports had shrunk from 350 MW to 128 MW. Through the second policy, the State Bank of Pakistan and the Alternative Energy Development Board will allow home-owners to leverage their mortgage to pay for the installation of solar panels for a value of up to five million rupees (*circa* US$50 000), with comparatively low interest rates (Clover, 2015).

Pakistan's first STI policy

Among the most critical determinants for the success of any country's STI sector are the institutional and policy systems responsible for managing relevant public policies. The Federal Ministry of Science and Technology has overseen the S&T sector since 1972. However, it was not until 2012 that Pakistan's first *National Science, Technology and Innovation Policy* was formulated: this was also the first time that the government had formally recognized innovation as being a long-term strategy for driving economic growth. The policy principally emphasizes the need for human resource development, endogenous technology development, technology transfer and greater international co-operation in R&D. However, it is not clear whether any part of the policy has been implemented since its release.

The policy was informed by the technology foresight exercise undertaken by the Pakistan Council for Science and Technology from 2009 onwards. By 2014, studies had been completed in 11 areas: agriculture, energy, ICTs, education, industry, environment, health, biotechnology, water, nanotechnology and electronics. Further foresight studies are planned on pharmaceuticals, microbiology, space technology, public health (see a related story in Box 21.6), sewage and sanitation, as well as higher education.

R&D intensity to triple by 2018

Following the change of government in Islamabad after the May 2013 general election, the new Ministry of Science and Technology issued the draft *National Science, Technology and Innovation Strategy 2014–2018,* along with a request for comments from the public. This strategy has been mainstreamed into the government's long-term development plan, *Vision 2025*, a first for Pakistan. The central pillar of the draft *National Science, Technology and Innovation Strategy* is human development. Although the pathway to implementation is not detailed, the new strategy fixes a target of raising Pakistan's R&D spending from 0.29% (2013) to 0.5% of GDP by 2015 then to 1% of GDP by the end of the current government's five-year term in 2018. The ambitious target of tripling the GERD/GDP ratio in just seven years is a commendable expression of the government's resolve but ambitious reforms will need to be implemented concurrently to achieve the desired outcome, as greater spending alone will not translate into results.

Little change in the R&D sector

In Pakistan, the government is very present in the R&D sector, both through public investment in defence and civilian technologies and through state-operated bodies. According to the R&D survey undertaken by the Pakistan Council for Science and Technology in 2013, the government's R&D organizations receive nearly 75.3% of national R&D spending.

The share of the population engaged in R&D dropped between 2007 and 2011, be they researchers or technicians. However, growth then picked up between 2011 and 2013; these trends correlate with the relatively static levels of government spending in the R&D sector through its various organizations, which has not kept pace with economic growth.

In the public sector, about one in four researchers are engaged in the natural sciences, followed by the agricultural sciences and engineering and technology. Almost one in three researchers were female in 2013. Women made up half of researchers in medical sciences, about four out of ten in natural sciences but only one in six engineers and one in ten agricultural scientists. The great majority of state researchers work in the higher education sector, a trend that has become more pronounced since 2011 (Table 21.4).

The fact that the business enterprise sector is not surveyed does not augur well for monitoring progress towards a knowledge economy. Moreover, neither *Vision 2025,* nor the draft *National Science, Technology and Innovation Strategy 2014– 2018* proposes strong incentives and clear roadmaps for fostering the development of industrial R&D and university–industry ties.

Box 21.6: An app tracks a dengue outbreak in Pakistan

In 2011, Pakistan's largest province, Punjab, experienced an unprecedented dengue epidemic which infected over 21 000 citizens and resulted in 325 deaths. With the provincial health system in crisis mode, the authorities were rapidly overwhelmed, unable to track simultaneous interventions being undertaken by multiple departments, let alone predict locations where dengue larvae might appear.

At this point, the Punjab Information Technology Board stepped in. A team led by Professor Umar Saif, a former academic from the University of Cambridge (UK) and Massachusetts Institute of Technology (USA), designed a smartphone application to track the epidemic.

The application was pre-installed on 15 000 low-cost Android phones for as many government officials, who were required to upload before and after photographs of all their anti-dengue interventions. The entire data set was then geo-coded and displayed on a Google Maps-based dashboard, freely accessible to the public via internet and to senior government officials through smartphones. Teams of surveyors were despatched throughout the Lahore district, the provincial capital with the most dengue cases, to geo-code high-risk locations with dengue larvae, particularly around the homes of dengue-infected patients. The steady stream of geospatial data was then entered into a predictive algorithm to become an epidemic early warning system accessible to policy-makers at the highest level of government.

The project enabled the authorities to control the spread of the disease. The number of confirmed cases fell to 234 in 2012, none of which were fatal.

Source: High (2014); Rojahn (2012)

Table 21.4: **Researchers (FTE) in Pakistan's public sector by employer, 2011 and 2013**

	Government	Women (%)	Higher education	Women (%)	Share of total researchers working in government (%)	Share of total researchers working in higher education (%)
2011	9 046	12.2	17 177	29.6	34.5	65.5
2013	8 183	9.0	22 061	39.5	27.1	72.9

Note: Data for Pakistan exclude the business enterprise sector. FTE refers to full-time equivalents.

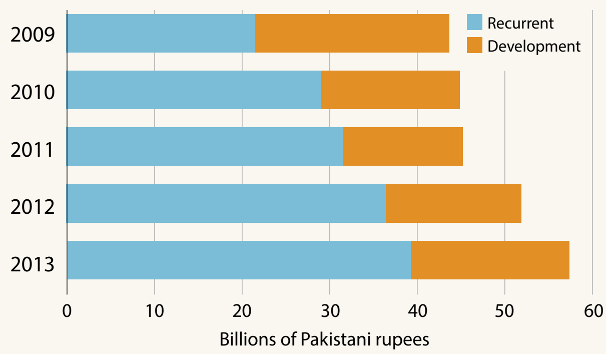
Source: UNESCO Institute for Statistics, June 2015

Decentralization of higher education governance

In 2002, the University Grants Commission was replaced with the Higher Education Commission (HEC), which has an independent chairperson. The HEC has been charged with reforming Pakistan's higher education system by introducing better financial incentives, increasing university enrolment and the number of PhD graduates, boosting foreign scholarships and research collaboration and providing all the major universities with state-of-the-art ICT facilities.

Between 2002 and 2009, the HEC succeeded in increasing the number of PhD graduates to 6 000 per year and in providing up to 11 000 scholarships for study abroad. It also introduced an e-library and videoconferencing facilities, according to the *UNESCO Science Report 2010*. The number of Pakistani publications recorded in the Web of Science leapt from 714 to 3 614 over the same period. The range of achievements during the reform period remains unprecedented in the history of Pakistan's higher education and R&D sectors. Moreover, publications in the Web of Science have since pursued their progression (Figure 21.8). This progress in scientific productivity appears to be due to the momentum generated by the larger numbers of faculty (Table 21.4) and student scholarships for study abroad, as well as the swelling ranks of PhD graduates.

Figure 21.12: **Pakistani Higher Education Commission's budgetary allocations, 2009–2014**



Source: Higher Education Commission of Pakistan

Despite these dramatic quantitative improvements across a variety of indicators, critics argue that this so-called 'numbers game' has compromised quality, a claim supported by the stagnation of Pakistani universities in global education rankings (Hoodbhoy, 2009).

Irrespective of this disagreement, the HEC found itself on the brink of dissolution in 2011–2012 in the face of the 18th amendment to the Constitution, which devolved several governance functions to provincial governments, including that of higher education. It was only after the Supreme Court intervened in April 2011, in response to a petition from the former Chair of the HEC, that the commission was spared from being divided up among the four Provinces of Baluchistan, Khyber–Pakhtunkhwa, Punjab and Sindh.

Notwithstanding this, the HEC's developmental budget – that spent on scholarships and faculty training, etc. – was slashed by 37.8% in 2011–2012, from a peak of R. 22.5 billion (*circa* US$ 0.22 billion) in 2009–2010 to Rs 14 billion (*circa* US$ 0.14 billion). The higher education sector continues to face an uncertain future, despite the marginal increase in developmental spending wrought by the new administration in Islamabad: Rs. 18.5 billion (*circa* US$ 0.18 billion) in the 2013–2014 budget.

In defiance of the Supreme Court ruling of April 2011, the provincial assembly of Sindh Province passed the unprecedented Sindh Higher Commission Act in 2013 creating Pakistan's first provincial higher education commission. In October 2014, Punjab Province followed suit as part of a massive restructuring of its own higher education system.

In sum, Pakistan's higher education sector is in transition, albeit with legal complications, towards a devolved system of governance undertaken at the provincial level. Although is too early to assess the potential impact of these developments, it is clear that the momentum of growth in spending and graduates in the higher education sector during the first decade of the century has now been lost. According to HEC statistics, the organization's budget as a percentage of national GDP has consistently fallen from the 2006-2007 peak of 0.33% to 0.19% in 2011–2012. In the interests of *Vision 2025*'s stated goal of building a knowledge economy, Pakistan's public policy apparatus will need to undertake a fundamental reprioritization of development spending, such as by giving itself the means to reach the target of devoting 1% of GDP to higher education.

Despite the turbulence caused by the legal battle being waged since the 2011 constitutional amendment discussed earlier, the number of degree-awarding institutions continues to grow throughout the country, both in the private and public sectors. Student rolls has been rising in tandem, from only 0.28 million in 2001 to 0.47 million in 2005, before crossing the 1.2 million mark in 2014. Just under half of universities are privately owned (Figure 21.13).

STI mainstreamed into development

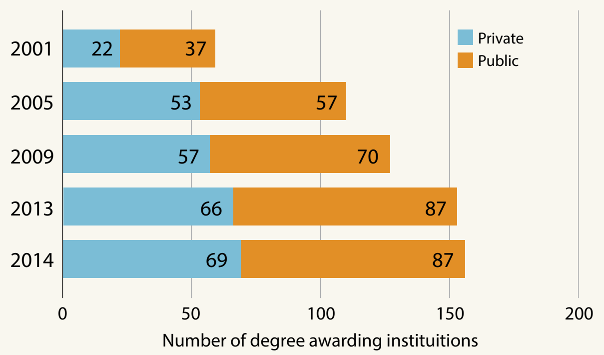
The overall picture of the STI sector in Pakistan is at best a mixed one. While the higher education sector faces an uncertain future, the government's mainstreaming of STI thinking into the national development narrative could signal a turnaround. Although indicators clearly show growth in higher education, they do not necessarily imply that the quality of education and research has also improved.

Moreover, the growth in PhD graduates and scientific publications does not appear to be having a discernible impact on innovation, as measured by patent activity. According to the World Intellectual Property Rights Organization (WIPO), patent applications[10] from Pakistan increased from 58 to 96 between 2001 and 2012 but the proportion of successful applications over the same period fell from 20.7% to 13.5%. This poor performance indicates a lack of a meaningful relationship between the university reforms and their impact on industry (Lundvall, 2009). As discussed above, the public sector continues to play a dominant role in the STI market, whereas the private sector appears to be lagging (Auerswald *et al*., 2012). This is also indicative of the non-existence of an appropriate entrepreneurial avenue (or culture), which is affecting Pakistan's global economic competitiveness.

Despite the mainstreaming of the national STI policy within national development policy, its potential impact on programmatic interventions remains far from clear. In order to achieve its goal of becoming a knowledge economy, Pakistan still requires a bolder vision from decision-makers at all levels of government.

10. These statistics are based on data collected from IP offices or extracted from the PATSTAT database. Source: www.wipo.int

Figure 21.13: **Growth in number of Pakistani universities, 2001–2014**



Source: Higher Education Commission of Pakistan

SRI LANKA

Strong growth since conflict's end

Mahinda Chintana: Vision for the Future 2020 (2010) is the overarching policy setting Sri Lanka's development goals to 2020; it aims to turn Sri Lanka into a knowledge economy and one of South Asia's knowledge hubs. The newfound political stability since the end of the prolonged civil war in 2009 has spawned a building boom since 2010, with the government investing in strategic development projects to build or expand motorways, airports, seaports, clean coal plants and hydropower. These projects are designed to turn Sri Lanka into a commercial hub, naval/maritime hub, aviation hub, energy hub and tourism hub. The Strategic Investment Projects Act of 2008 (amended in 2011 and 2013) was introduced to provide a tax-free period for the implementation of strategic development projects.

In order to attract FDI and technology transfer, the government has signed a series of agreements with foreign governments, including those of China, Thailand and the Russian Federation. Within an agreement signed in 2013, for instance, the Russian State Atomic Energy Corporation (ROSATOM) is assisting Sri Lanka's Atomic Energy Authority in developing nuclear energy infrastructure and a nuclear research centre, as well as providing training for workers. In 2014, the government signed an agreement with China for the expansion of the Port of Colombo and the development of infrastructure (port, airport and motorway) in Hambantota, which the government plans to turn into Sri Lanka's second urban hub after the capital. The agreement with China also covers technical co-operation on the Norochcholai Coal Power Project.

Between 2010 and 2013, GDP increased by 7.5% per year on average, up from 3.5% in 2009. In parallel, GDP per capita grew by 60% from US$2 057 to US$ 3 280 between 2009 and 2013. Although Sri Lanka's rank in the knowledge economy index dropped from 4.25 to 3.63 between 1999 and 2012, it remains higher than for all other South Asian countries.

Sri Lanka has made the transition from an agricultural economy to one based on services and industry (Figure 21.10) but the proportionate supply of science and engineering graduates from local universities is lower than for other disciplines.

Higher education reforms seek to expand capacity

Sri Lanka is likely to achieve universal primary education and gender parity by 2015, according to UNESCO's *Education for All Global Monitoring Report* (2015). One concern is the low level of public spending on education, which even dropped between 2009 and 2012 from 2.1% to 1.7% of GDP, the lowest level in South Asia (Figure 21.3).

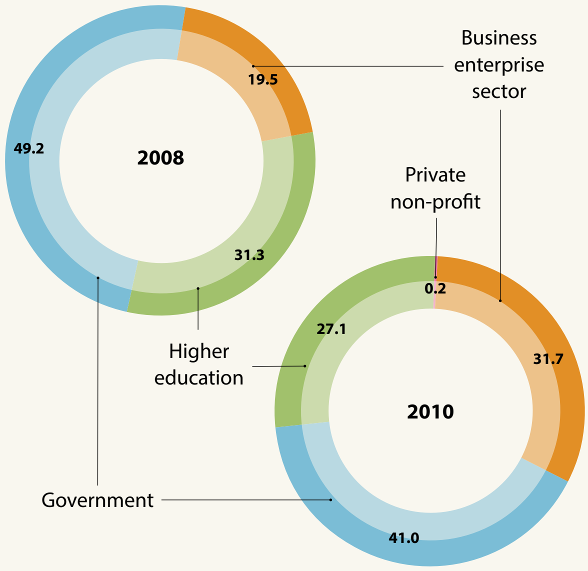
Sri Lanka counts 15 state-controlled universities which operate under the University Grants Commission (UGC) and a further three under the Ministries of Defence, Higher Education and Vocational and Technical Training. These 18 state universities are complemented by 16 registered private universities offering bachelor's or master's degrees.

At 0.3% of GDP, Sri Lanka's public spending on higher education is one of the lowest in South Asia, on a par with that of Bangladesh. According to the UGC, only 16.7% of the students who qualified for university could be admitted for the year 2012–2013. These factors explain the relatively low proportion of researchers in Sri Lanka – a head count of just 249 per million inhabitants in 2010 – , and the modest progress in recent years (Figure 21.7). Of note is that the share of researchers working in the business enterprise sector (32% in full-time equivalents for 2010) is approaching that of India (39% in 2010), a trend which augurs well for the development of a dynamic private sector in Sri Lanka (Figure 21.14). In 2012, the Sri Lankan government announced tax incentives for private companies undertaking R&D and for the use of public research facilities.

The government has spent the past few years addressing the insufficient number of university places. This is one of the objectives of the Higher Education for the Twenty-first Century Project (2010–2016), which aims to ensure that universities are in a position to deliver quality services aligned with the country's socio-economic needs. The mid-term review in 2014 identified the following achievements:

- progressive implementation of the Sri Lanka Qualification Framework (SLQF, est 2012) by national institutes and universities; it regulates the ten levels of qualification offered by public and private post-secondary institutions to enhance equity in higher education, training and job opportunities and facilitate lateral and vertical mobility in the university system; the SLQF integrates the National Vocational Qualification Framework (2005) and identifies pathways for ensuring mobility between vocational and higher education by providing a nationally consistent basis for recognizing prior learning and the transfer of credits;

Figure 21.14: **Sri Lankan researchers (FTE) by sector of employment, 2008 and 2010**



Source: UNESCO Institute for Statistics, June 2015

- implementation of University Development Grants to improve the skills of students at all universities in relation to information technology (IT), English and soft skills, such as conscientiousness or leadership qualities, which are valued by employers at all target 17 universities;
- implementation of Innovatory Development Grants for university students enrolled in the arts, humanities and social sciences at all target 17 universities;
- award of Quality and Innovation Grants (QIG), which enhance the quality of academic teaching, research and innovation, to 58 study programmes, exceeding the project target of 51; nearly all QIGs are performing well;
- enrolment of over 15 000 students in advanced technological institutions, surpassing the current project target of 11 000;
- commencement of master's or PhD degree programmes by over 200 academics from universities and the Sri Lanka Institute of Advanced Technological Education, exceeding the project target of 100 master's/PhD degrees; and
- about 3 560 beneficiaries of short-term professional development activities targeting university administrators and managers, academics and technical and support staff.

Greater mobility for Sri Lankan engineers

In June 2014, the premier body for engineers in Sri Lanka, the Institution of Engineers, became a signatory of the Washington Accord, along with its Indian counterpart. The Washington Accord is an international agreement by which bodies responsible for accrediting engineering degree programmes recognize the graduates of other signatory bodies as having met the academic requirements for entry into the engineering profession. This recognition offers future Sri Lankan and Indian engineers easy mobility throughout the signatory countries.[11]

Sri Lanka's first STI policy

Sri Lanka's first comprehensive *National Science and Technology Policy* was adopted in June 2009, following a thorough consultative process with all stakeholders, as outlined in the *UNESCO Science Report 2010*. These consultations identified the need to develop a science and innovation culture, build human resource capabilities and promote R&D and technology transfer. Participants also felt that the policy should foster sustainability and indigenous knowledge, propose a defined system of intellectual property rights and promote the application of science and technology for human welfare, disaster management, adaptation to climate change, law enforcement and defence.

Under the objective of 'Enhancing Science and Technology Capability for National Development', the policy identifies strategies for increasing ' the state sector investment in science and technology to 1% of GDP by 2016 and facilitating the non-state sector investment in R&D to at least 0.5% of the GDP by 2016.' This is an ambitious target, since the government devoted just 0.09% of GDP to GERD in 2010 and the business enterprise sector (public and private) a further 0.07%.

Approved by the Cabinet in 2010, the *National Science, Technology and Innovation Strategy* (2011–2015) serves as the roadmap for implementing the *National Science and Technology* Policy. The body responsible for piloting the strategy, the Co-ordinating Secretariat for Science, Technology and Innovation (COSTI), was set up for this purpose in 2013. COSTI is currently preparing an evaluation of the national research and innovation ecosystem.

The *National Science, Technology and Innovation Strategy* (2011–2015) identifies four broad goals:

- Harness innovation and technology to economic development through focused R&D and dynamic technology transfer to increase the share of high-tech products for export and the domestic market; the main target of the Advanced Technology Initiative is to raise the share of high-tech products among exports from 1.5% in 2010 to 10% by 2015;
- Develop a world-class national research and innovation ecosystem;
- Establish an effective framework to prepare the population of Sri Lanka for a knowledge society; and
- Ensure that the sustainability principle is entrenched in all spheres of scientific activity to ensure socio-economic and environmental sustainability.

A better quality of life through R&D

Adopted in July 2014, the *National Investment Framework for Research and Development for 2015–2020* identifies ten focus areas for investment in R&D to improve the quality of life. Relevant government ministries and other public and private institutions were asked to take part in the study, in order to recommend national R&D priorities.

The ten focus areas are:

- Water;
- Food, nutrition and agriculture;
- Health;
- Shelter;
- Energy;
- Textile industry;
- Environment;
- Mineral resources;
- Software industry and knowledge services;
- Basic sciences, emerging technologies and indigenous knowledge.

Nanotechnology a priority

Development of the industrial sector has accelerated since the Cabinet approved[12] the *National Biotechnology Policy* in 2010 and the *National Nanotechnology Policy* in 2012.

Nanotechnology got its first institutional boost in 2006 with the launch of the National Nanotechnology Initiative. Two years later, the government established the Sri Lanka Institute of Nanotechnology (SLINTEC) in an unprecedented joint venture with the private sector (Box 21.7). In 2013, the Nanotechnology and Science Park opened, along with the Nanotechnology Centre of Excellence, which provides high quality infrastructure for nanotechnology research. In 2013, Sri Lanka ranked 83rd for the number of nano-articles in the Web of Science per million inhabitants (Figure 21.8). It trails Pakistan (74th), India (65th) and Iran (27th) for this indicator (for India and Iran, see Figure 15.5).

11. Among the other signatories are Australia, Canada, Ireland, Japan, Rep. Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, the UK and USA. See: www.iesl.lk

12. A third sectorial policy on human genetic material and data was still in draft form at the time of writing in mid-2015.

Box 21.7: Developing smart industry through the Sri Lanka Institute of Nanotechnology

The Sri Lanka Institute of Nanotechnology (SLINTEC) was established in 2008 as in a joint venture between the National Science Foundation and Sri Lankan corporate giants that include Brandix, Dialog, Hayleys and Loadstar. Its aims are to:

- build a national innovation platform for technology-based economic development by helping to raise the proportion of high-tech exports from 1.5% to 10% of total exports by 2015 and through the commercialization of nanotechnology;
- deepen collaboration between research institutes and universities;
- introduce nano-aspects of leading technologies and industries to make Sri Lankan products more competitive globally and add value to Sri Lanka's natural resources;
- bring nanotechnology research and business enterprises together; and
- attract expatriate Sri Lankan scientists by creating a sustainable ecosystem.

Less than one year after its inception, SLINTEC filed five international patents with the United States Patent and Trademark Office, a remarkable achievement. Two additional patent applications were filed in 2011 and 2012. These inventions include a process for the preparation of carbon nanotubes from vein graphite; compositions for sustained release of agricultural macronutrients and related processes; a cellulose-based sustained release macronutrient composition for fertilizer application; a process for reinforcing elastomer-clay nano-composites; a process for preparing nanoparticles from magnetite ore; a nanotechnology-based sensor unit; a composition for stain and odour removal from bio-polymeric fabrics, etc.

Gunawardena (2012) identified the focus areas of SLINTEC as:

- *Smart agriculture:* nanotechnology-based slow release fertilizer; potential expansion to sensors and next generation fertilizers;
- *Rubber nano-composites:* high-performance tyres;
- *Apparel and textile:* high-end fabrics, smart yarns and other technologies;
- *Consumer products:* a nanotechnology-based external medical sensor with a view to enabling remote health monitoring, detergents, cosmetics, etc.;
- *Nano-materials:* ilmenite, clay, magnetite, vein quartz and vein graphite to develop titanium dioxide, montmorillonite, nanomagnetite, nanosilica and graphite nanoplatelets.

Source: http://slintec.lk

Schemes to foster innovation

The National Science Foundation has instituted two technology grant schemes to encourage innovation. The first (Tech D) helps universities, research institutes, private firms and individuals develop their ideas, whereas the second focuses on start-ups based on novel technologies. In 2011, five Tech D grants and one start-up grant were awarded.

In 2013, the Ministry of Technology and Research organized its third Technology Marketplace exhibition to provide a forum where scientific research and industry could meet. The ministry has directed its five research bodies to focus on demand-driven research: the Industrial Technology Institute, National Engineering Research and Development Centre, Atomic Energy Board, SLINTEC and the Arthur C. Clarke Institute for Modern Technologies.

In 2010, the USA-based Blue Ocean Ventures launched the Lankan Angels Network. By 2014, the investors operating within this network had injected US$1.5 million into 12 innovative Sri Lankan companies, within a partnership with the Sri Lankan Inventors Commission (est. 1979). The Ministry of Technology and Research reported in 2013 that the Commission had disbursed just LKR 2.94 million (*circa* US$ 22 000) in grants through its own Inventor's Fund the same year.

Smart people, smart island

The first framework for generalizing ICTs was the e-Sri Lanka roadmap launched in 2002, which spawned the Information and Communication Technology Act and the founding of the government-owned Information and Communication Technology Agency (ICTA) in 2003. ICTA implemented the government's e-Sri Lanka Development Project, which sought to bring ICTs to every village, until the project's end in 2013. By 2013, 22% of the population had access to internet, compared to just 6% in 2008, and 96% had a mobile phone subscription.

Phase 2 of the e-Sri Lanka Development Project was launched by ICTA in 2014, in order to spur economic development through innovation in ICTs. Known as Smart Sri Lanka, the project is expected to run for about six years. Its slogan is 'smart people, smart island.' Its goals could be summed up as: smart leadership, smart government, smart cities, smart jobs, smart industries and a smart information society.

Smart Sri Lanka reposes on six programmatic strategies to achieve its goal:

- ICT policy, leadership and institutional development;
- Information infrastructure;
- Re-engineering government;
- ICT human resource development;
- ICT investment and private sector development; and
- The e-society.

In parallel, ICTA has set up telecentres *(nenasalas)* across the country, in order to connect communities of farmers, students and small entrepreneurs to information, learning and trading facilities. These telecentres provide people with access to computers, internet and training in IT skills. The *nenasalas* also provide access to local radio broadcasts of market prices and agricultural information for farmers; e-health and telemedecine facilities for rural patients; and digital 'talking books' (audio books) for the visually impaired. Three types of *nenasala* have been implemented: rural knowledge centres; e-libraries; and distance and e-learning centres. As of August 2014, there were 800 *nenasalas* across the country.[13]

CONCLUSION

A need to blend local and external capacity

There have been some significant improvements in education since 2010 in South Asia, along with more modest progress in developing national innovation systems. In both areas, low levels of public funding have been an obstacle to development but, in the case of education, government efforts have been supplemented by projects funded by international donor agencies. Despite gains in net primary school enrolment, uptake to secondary-level education enrolment nevertheless remains relatively low: the most populous countries, Bangladesh and Pakistan, have reported levels of only 61% (2013) and 36% (2012) respectively.

Universal primary and secondary education is only the first step towards developing the requisite professional and technical skills that countries will need to realize their ambition of becoming a knowledge economy (Pakistan and Sri Lanka) or middle-income country (Bangladesh, Bhutan and Nepal) within the next decade. Building an educated labour force will be a prerequisite for developing the high-value-added industries needed to undertake the desired industrial diversification. Education planning will need to include investment in infrastructure, programmes to improve teaching skills and the development of curricula that match skills with employment opportunities.

13. See: www.nenasala.lk

In order to exploit a broad spectrum of opportunities, national innovation systems should be designed to enable both the development of local capacity in research and innovation and the acquisition of external knowledge and technologies which can generally be found in locally operated, technologically advanced firms. Whereas the majority of industries in South Asia are not yet technologically advanced, there are nevertheless a few local firms that have become internationally competitive, particularly in Pakistan and Sri Lanka. Given the heterogeneity among firms in terms of their technological innovativeness, the national innovation system will need to be sufficiently flexible to support their different technological requirements. Whereas local innovation systems are usually designed to support R&D-led innovation, countries that are able to capitalize systemically on the accumulated capabilities of high-performing local firms and implanted multinationals to nurture their industries are likely to generate broader innovative capabilities.

Economic development through FDI requires a high level of local responsiveness and absorptive capacity, in particular with regard to technology diffusion. The FDI inflows to the South Asian economies reviewed in the present chapter have not significantly contributed to their growth, in comparison with countries in East Asia. Technologically advanced economic sectors where value chain activities are able to utilize existing local knowledge, skills and capabilities have an opportunity to upgrade their local industries.

Governments need to ensure that sufficient funds are available for the implementation of national research and education policies. Without adequate resources, it is unlikely that these policies will bring about effective change. Governments are aware of this. Pakistan has set targets to increase its investment in R&D to 1% of GDP by 2018 and Sri Lanka plans to increase its own investment to 1.5% of GDP by 2016, with a public sector contribution of at least 1%. These targets look good on paper but have governments put in place the mechanisms to reach them? Spending on R&D also has to be prioritized, if limited financial and human resources are to make the desired impact.

Public–private partnerships can be an important ally in policy implementation – as long as the private sector is sufficiently robust to shoulder part of the burden. If not, tax incentives and other business-friendly measures can give the private sector the boost it needs to become an engine of economic development. Public–private partnerships can create synergies between firms, public R&D institutes and universities for industry-led innovation, one obvious example in this respect being SLINTEC (Box 21.7).

The lack of infrastructural capacity to support the use of internet remains a challenge for many South Asian countries. This leaves them unable to connect their own internal urban and rural economies or with the rest of the world. All countries have made efforts to include ICTs in education but the availability and quality of the electricity supply in rural areas and the deployment of ICTs are still major concerns. Mobile phone technology is widespread, being used by farmers, school children, teachers and businesses; this almost ubiquitous, easily accessible and affordable technology represents an enormous but still underutilized opportunity for information- and knowledge-sharing, as well as for the development of commercial and financial services across urban and rural economies.

KEY TARGETS FOR SOUTH ASIAN COUNTRIES

- Raise the share of higher education to 20% of the Afghan education budget by 2015;
- Ensure that women represent 30% of Afghan students and 20% of faculty by 2015;
- Raise the contribution of industry to 40% of GDP in Bangladesh and increase the share of workers employed by industry to 25% of the labour force by 2021;
- Reduce the share of workers employed in agriculture in Bangladesh from 48% of the labour force in 2010 to 30% in 2021;
- Create a National Council for Research and Innovation in Bhutan;
- Broaden access to higher education in Pakistan from 7% to 12% of the age cohort and increase the number of new PhDs per year from 7 000 to 25 000 by 2025;
- Raise Pakistan's GERD to 0.5% of GDP by 2015 and to 1% of GDP by 2018;
- Increase expenditure on higher education to at least 1% of GDP in Pakistan by 2018;
- Raise Sri Lanka's GERD from 0.16% of GDP in 2010 to 1.5% of GDP by 2016, to which the private sector should contribute 0.5% of GDP, compared to 0.07% in 2010;
- Augment the share of Sri Lankan high-tech products from 1.5% (2010) to 10% of exports by 2015.

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