



APRU
IMPACT
REPORT
2016

APRU

Association of Pacific Rim Universities

Vision

Seeing the rapid economic integration of the region and the formation of APEC, the founding presidents' vision was to establish a premier alliance of research universities as an advisory body to international organisations, governments and businesses on the development of science and innovation as well as on the broader development of higher education. The vision now encompasses focusing new knowledge on the global challenges affecting the region.

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Figures

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Glossary

Most terms are explained in the paragraph in which they occur. Some key terms are defined here:

AAU	Association of American Universities
Altmetrics	Altmetrics are non-traditional metrics for publications such as social media citations. Examples include news stories, blogs, tweets, Facebook posts, Google + posts and Reddit posts on articles.
APEC	Asia-Pacific Economic Cooperation: a forum for 21 Pacific Rim member economies that promotes free trade throughout the Asia-Pacific region. For context the APEC region contains 2,616 publishing research institutions.
ASEAN	Association of Southeast Asian Nations
APRU	Association of Pacific Rim Universities
APWiL	Asia-Pacific Women in Leadership (APRU Core Group)
Bibliometrics	Statistical analysis of written publications, including journal articles, books and other academic literature. Analysis can be carried out on the subject matter, authors and affiliations, collaborators and references to or within the publications in question.
C9 League	An alliance of nine universities in mainland China
Climatological hazard	Refers here to a hazard caused by long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability. Includes droughts and wildfires.
CPP	Citations per publication
DRR	Disaster risk reduction: the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. (As defined by UNISDR)
Disaster management	The systematic process of using administrative directives, organisations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. A broader term than DRR. (As defined by UNISDR)
ENSO	El Niño – Southern Oscillation is an irregular periodical variation in winds and sea surface temperatures over the tropical eastern Pacific Ocean. The warming phase is known as <i>El Niño</i> and the cooling phase as <i>La Niña</i> .
FWCI	Field weighted citation index: the ratio of the total citations actually received by the output, and the total citations that would be expected based on the average of the subject field, also taking into account the age of the publication
GDP	Gross domestic product, the monetary value of all the finished goods and services produced within a country's borders in a specific time period.
Geophysical hazard	Refers here to a hazard originating from solid earth. This term is used interchangeably with the term geological hazard. Includes earthquakes, tsunamis and volcanoes.
GEJET	Great East Japan earthquake & tsunami
Go8	Group of Eight (group of leading Australian universities)
Gross Value Added	Gross value added is the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector. Domestic value added in gross exports is an estimation of value added, by an economy, in producing goods and services for export.
HRDWG	APEC Human Resources Development Working Group
Hydrological hazard	A hazard caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater. Includes floods and landslides
IP	Intellectual property

MERS	Middle East respiratory syndrome (MERS), also known as camel flu, is a viral respiratory infection caused by the MERS-coronavirus (MERS-CoV)
Meteorological hazard	Refers here to a hazard caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions that last from minutes to days. Includes tornadoes, cyclones, hurricanes, storms, extreme temperatures.
MH Program	APRU Multi-Hazards Program for safer and more disaster-resilient societies
MOOCs	Massive open online courses: courses available via the internet
NGO	Non-governmental organisation: not part of government nor a normal profit-making concern, e.g. a charitable relief organisation
OECD	Organisation for Economic Co-operation and Development, a forum of 34 economies working together to promote economic growth, prosperity and sustainable development
Outputs in top percentiles	Publications in the top worldwide publications based on their citations (here taken as publications in the top 10% of the world by citations unless otherwise specified)
Patent-cited output	Publications cited in patents
PECC	Pacific Economic Cooperation Council (PECC): network of member committees composed of individuals and institutions dedicated to promoting cooperation across the Asia Pacific region
PM_{2.5}	Fine particulate matter, less than 2.5 microns in diameter; believed to pose the greatest health risk of airborne pollutants because of their ability to penetrate the lungs
PNSN	Pacific Northwest Seismic Network, a collaboration between Universities of Washington and Oregon, state governments and US Geological Survey
PPP	Purchasing power parity: a method of adjusting exchange rates to take into account actual local purchasing power differences, i.e. the goods and services that can be bought with a given amount of money
Public expenditure on R&D	Combines expenditure in higher education institutions with expenditure at public research institutions, due to differences in system structures between countries
PV	Photovoltaic - having the function of converting light energy to electricity
R&D	Research and development
SARS	Severe acute respiratory syndrome (SARS) is a viral respiratory disease of zoonotic origin caused by the SARS coronavirus (SARS-CoV)
Scholarly output	Number of academic publications
Star publications	Publications which can be found in the top 10% of world publications based on their citations
Specialisation index	Here defined as the volume of publications in a discipline by an institution or group compared to the average ratio for that discipline worldwide. A high specialisation therefore refers to a group which produces a disproportionately high volume of output in this discipline for their size.
U.	Used in this report as an abbreviation for 'University'
UNISDR	UN International Strategy for Disaster Reduction
ULP	APRU Undergraduate Leaders Program

Foreword

This ground-breaking APRU Impact Report provides for the first time the evidence base for the contribution of leading research universities to the Asia-Pacific's most pressing challenges and to the social and economic well-being of our societies.

Government, industry and local communities across APEC economies, as well as other international organisations, increasingly seek to work with research universities on major issues from global health and gender equity to sustainability and climate change.

This report provides an overview of the expertise of APRU's member universities and the current state of play regarding international collaboration in key fields of research and education. It does this through contextual data, research metrics and case studies.

The APRU Impact Report is also a resource for outreach and advocacy by universities in support of higher education's role in knowledge creation, tech transfer and innovation. Our members, recognising they constitute a significant proportion of the research and innovation capabilities of the APEC economies, seek to engage more systematically with the international policy community.

This move to relate education and research to public policy is consistent with the vision of the four university presidents who established APRU twenty years ago: Thomas Everhart of Caltech, Chang-Lin Tien of UC, Berkeley, Charles Young of UCLA and my predecessor, Steven Sample of USC.

Inspired by the formation of APEC and the rapid economic integration of the Asia-Pacific region, they saw the need for an advisory body of university presidents from leading institutions around the region. Their aim was to go beyond sharing knowledge and experience amongst university presidents in a fast-changing higher education landscape. They took seriously the responsibility to contribute collective advice to policymakers in the area of science and innovation and to bring to the table new knowledge on global challenges.

I commend this report to you as a significant milestone in fulfilling that vision.

C.L. Max Nikias

Chairman, APRU

President, University of Southern California



Preface

This century is marked by the promise of technological innovation and by the risks of social disruption arising from inequality and threats to the biosphere.

The Asia-Pacific region, located around the world's largest ocean covering a third of the earth's surface, tectonically situated on the Ring of Fire, encompassing societies of huge diversity and economic dynamism, confronts daily the policy choices arising from these promises and risks.

The region's research universities seek to rise to the challenge of contributing collectively and more systematically to the international policy process through relating the latest research to comprehensive solutions.

The purpose of this APRU Impact Report is therefore twofold:

- To identify where specialist expertise is located in both research and education and in broader contributions to the social and economic wellbeing of Asia-Pacific societies
- To establish the value of international collaboration amongst universities and with external partners in order to highlight further opportunities for cooperation which will have impact.

Underlying the report are the assumptions that no single nation can solve the cross-border issues that confront them, that technical solutions of themselves will be inadequate without the critical social knowledge that will come from interdisciplinary research and from partnerships with international organisations, NGOs, cities and local communities, and that we have yet to leverage the social power of networks in relation to hierarchies.

This report is the first phase of a three-year pilot project during which we will refine, through annual reports, the information and analyses that will be most useful to policymakers. We therefore welcome feedback and critique.

This year's report presents data and case studies on the roles of research universities and the competencies of APRU universities which have a direct impact on the societies they serve and on the Asia-Pacific region. It then has a special focus on an area where our members are at the leading edge of global research: disaster science, risk reduction and recovery from major disasters such as tsunami, floods, earthquakes and volcanic activity.

I wish to thank the Presidential Reference Group and the Editorial Advisory Group for their advice and insights as well as their endorsement of the value of this project. I also thank Perspicuity Canada for undertaking the complex tasks of research and analysis and Elsevier for their sponsorship and for their collaboration as our data partner which has enabled us to understand and present information that has not been previously available.

Christopher Tremewan
Secretary General, APRU



Executive summary

Purpose of the APRU Impact Report: This report provides for the first time the evidence base for the contribution of APRU's 45 member universities to their societies and to the key opportunities and challenges of the Asia-Pacific region.

Its purpose is to spotlight the competencies of the Asia-Pacific's leading institutions in education, research and innovation which have a direct relationship to these challenges. It also aims to demonstrate the value of international cooperation between universities and with international organisations, governments, NGOs, the private sector and local communities and thereby to identify the areas where future cooperation will have maximum impact.

Findings

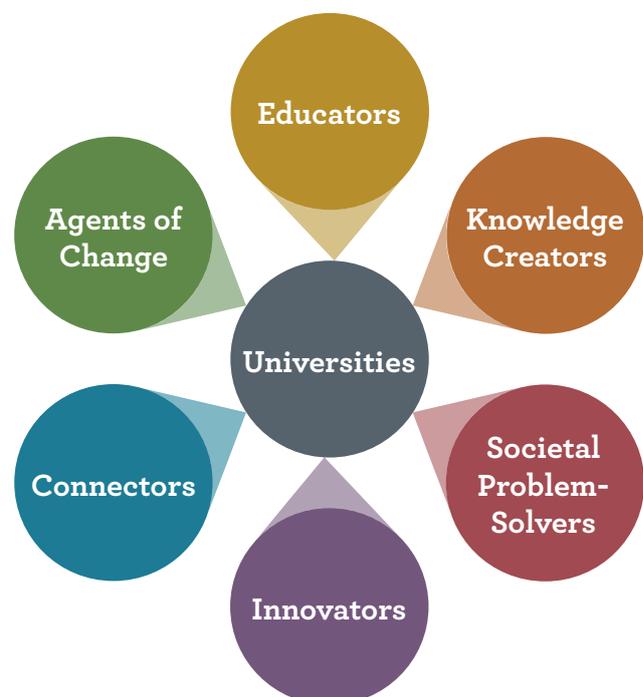
Drawing on the in-depth analysis that is now possible from mining huge research databases and from case studies, this report has found that APRU universities:

- exceed global and Asia-Pacific regional averages for performance in knowledge creation and research
- resource leadership in government, business and industry at high-levels with their graduates
- exercise extensive social influence across their societies through their alumni
- project impact nationally and internationally through their roles as educators, connectors, societal problem-solvers, innovators, agents of change, and knowledge creators
- bring the strength of diversity to solving global challenges
- boost the quality of research output through international collaborations
- act as international connectors and as a knowledge resource on a range of international challenges from disaster science to population ageing, from global health and the future of the digital economy to sustainability and climate change.

Highlights

Impact extends internationally

The impact of APRU institutions extends beyond the boundaries of the universities themselves to their societies and the Asia-Pacific region. The figure below captures the wide range of roles which produce this impact. More detail is provided in the report by means of quantitative analysis and qualitative case studies in Chapter 2. (Sections of this report are colour-keyed in the header according to the impact area matching the colours on the right.)



Knowledge Leadership

APRU institutions are thought leaders in their respective localities, punching above their weight in terms of research and creation of new knowledge across all metrics compared to world and Asia-Pacific regional averages (as demonstrated in Section 2.2, see page 16).

As educators, APRU institutions have produced successful graduates, including political leaders, Nobel Prize winners and business entrepreneurs (see Section 2.2).

These institutions continue to innovate through educational models which equip work-ready graduates for the future. Flexibility and success can be demonstrated through employer satisfaction and graduate employability (see Study 1).

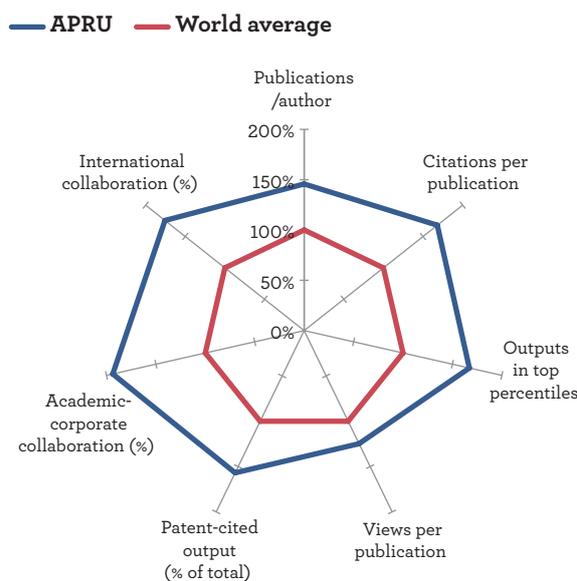


FIGURE from Section 2.2 – APRU research performance metrics relative to the world average (shown in red).

International Education

Education has become increasingly internationalised through international student flows and through the expansion of online education. APRU institutions show leadership in both areas: acting as physical educational hubs in the Asia-Pacific (page 25) and offering over 650 virtual programs (see page 11).

Societal Impact

APRU initiatives extend collaboration beyond the research realm, including sharing and applying knowledge to societal challenges as presented in various case studies throughout this report. APRU Research Programs in multi-hazards, population ageing, global health, the digital economy, sustainability and climate change have begun to demonstrate benefits for the region. Examples include sharing best practices for education of medical professionals (p 12), offering a forum for debate with industry on internet governance (p 27) or gathering data and policies on public health issues such as air pollution and water management (p 19).

Further examples of impact through current APRU activities can be found in case studies presented in the report, as well as in Chapter 3 focusing on multi-hazards and disaster management.

Connecting the Asia-Pacific region

Overall APRU researchers are highly collaborative, exceeding international and national collaboration rates compared to the world and the APEC regional average, and performing well compared with peer organisations (see Section 2.5 and chart repeated here).

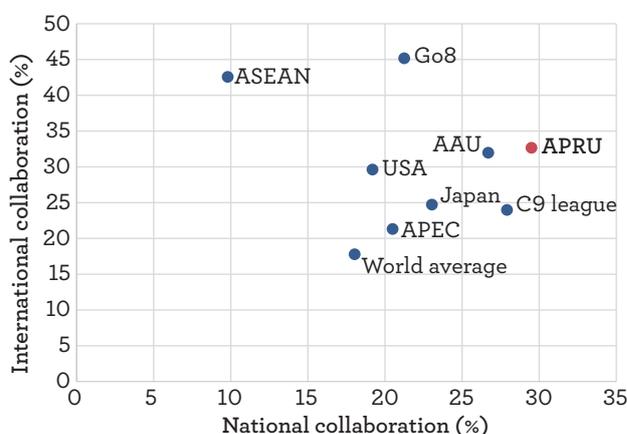


FIGURE 19 from Section 2.5, page 25.

Strength in diversity

APRU universities respond to a diversity of needs and environments, developing particular strengths and specialisations. Not all institutions focus equally on each of the areas listed above and, within a particular impact area or role, may choose different specialisations.

As a result, the network contains institutions that are both synergistic and complementary in terms of areas of expertise, thereby enabling collaboration of world-class experts within and across research specialisations, and providing a well-rounded overall research base (details can be found in Chapter 4).

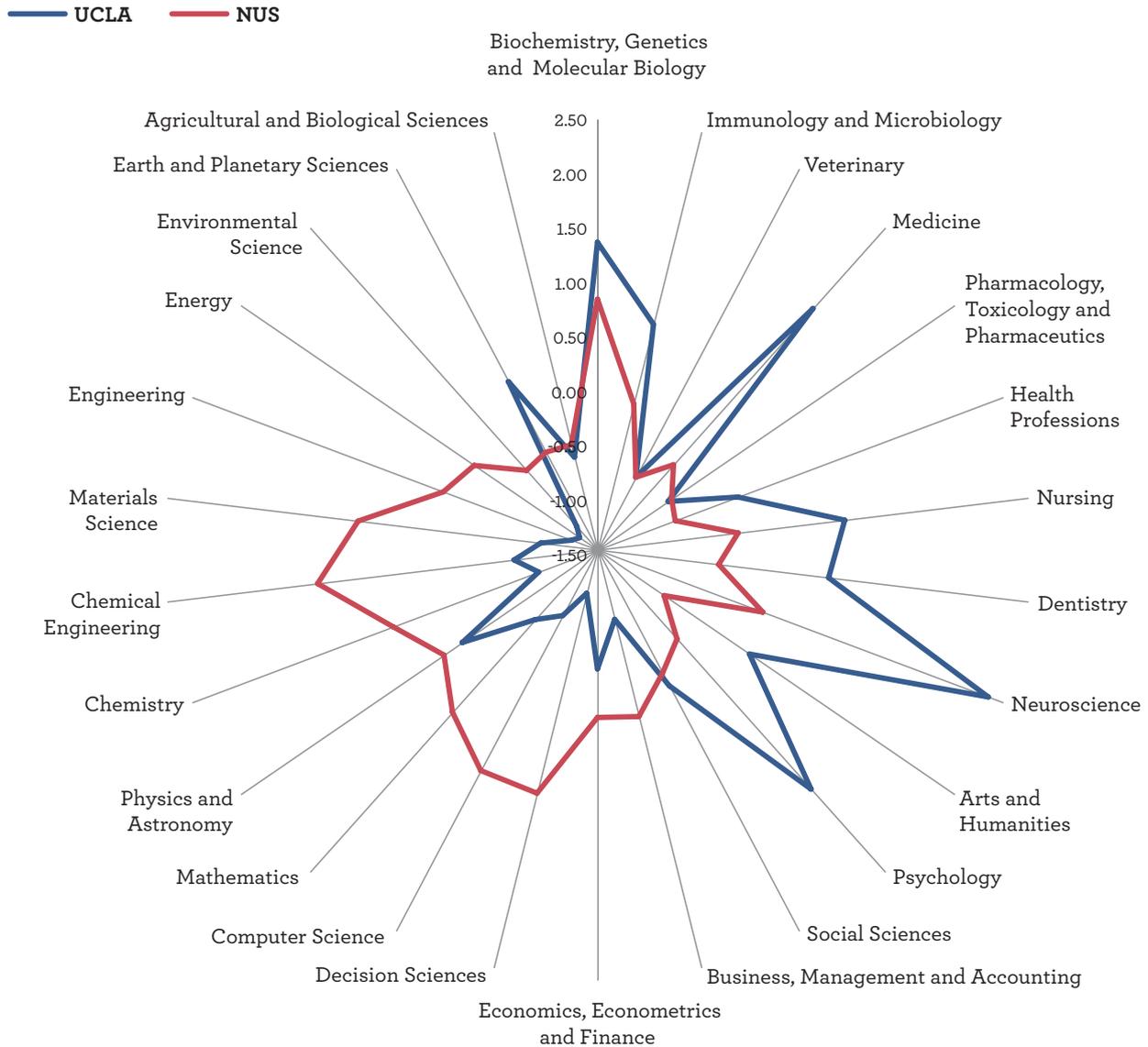


FIGURE from section 4.1.5 - Relative specialisation within APRU, by volume of output.

Collaboration enhances research quality

Collaboration within the network enhances research performance. Chapter 5 presents evidence that collaboration within APRU boosts citation rates of research, a commonly used proxy for measuring quality.

As a group in each discipline, APRU research has a quality index well above the world average, higher output volume is seen in disciplines related to Asia-Pacific regional challenges (such as earth and planetary sciences) and some areas of regional industry need (such as materials science).

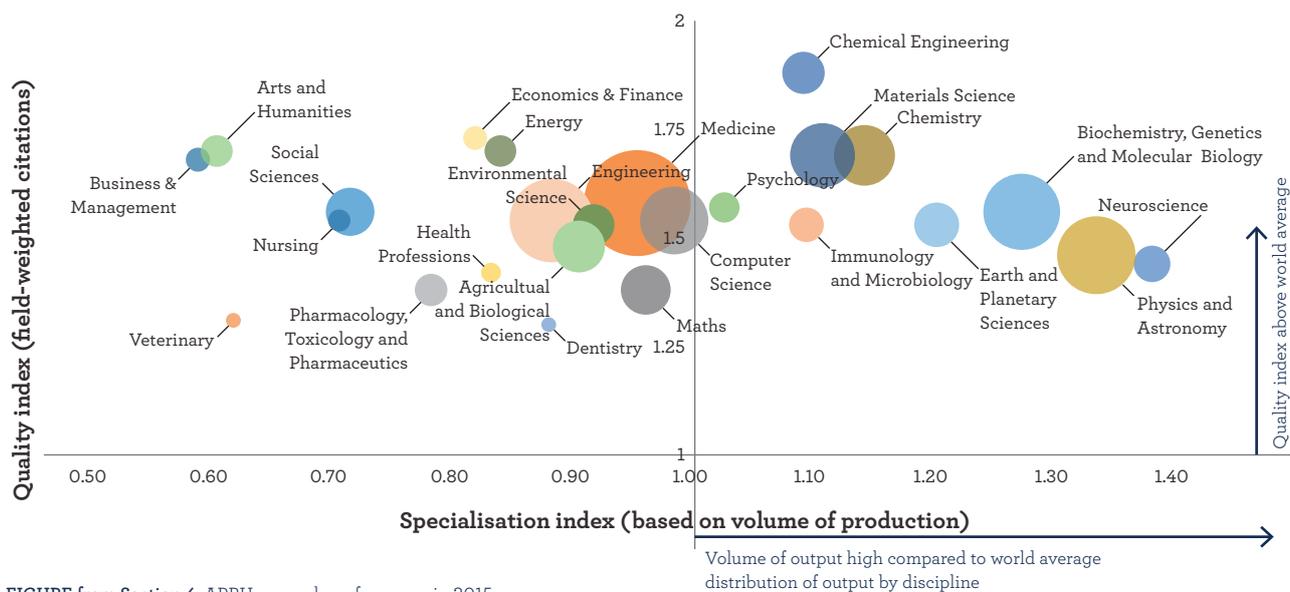


FIGURE from Section 4: APRU research performance in 2015

Report Structure

This report looks at the roles and contributions of APRU and its constituent institutions across the Asia-Pacific region. The emphasis is on recognising Asia-Pacific regional and local needs and identifying where universities have truly made and continue to make a societal impact.

CHAPTER 1

Provides context across the Asia-Pacific and for the economies in which institutions are situated. This provides background to understand constraints, challenges and opportunities that individual institutions are facing. It also offers an overview of diversity in of the region.

CHAPTER 2

Examines the different roles served by APRU and its institutions, considering their impact in each of these roles in turn through the use of case study examples.

CHAPTER 3

Focuses on how the work of universities translates to societal benefits in the context of disaster management.

CHAPTER 4

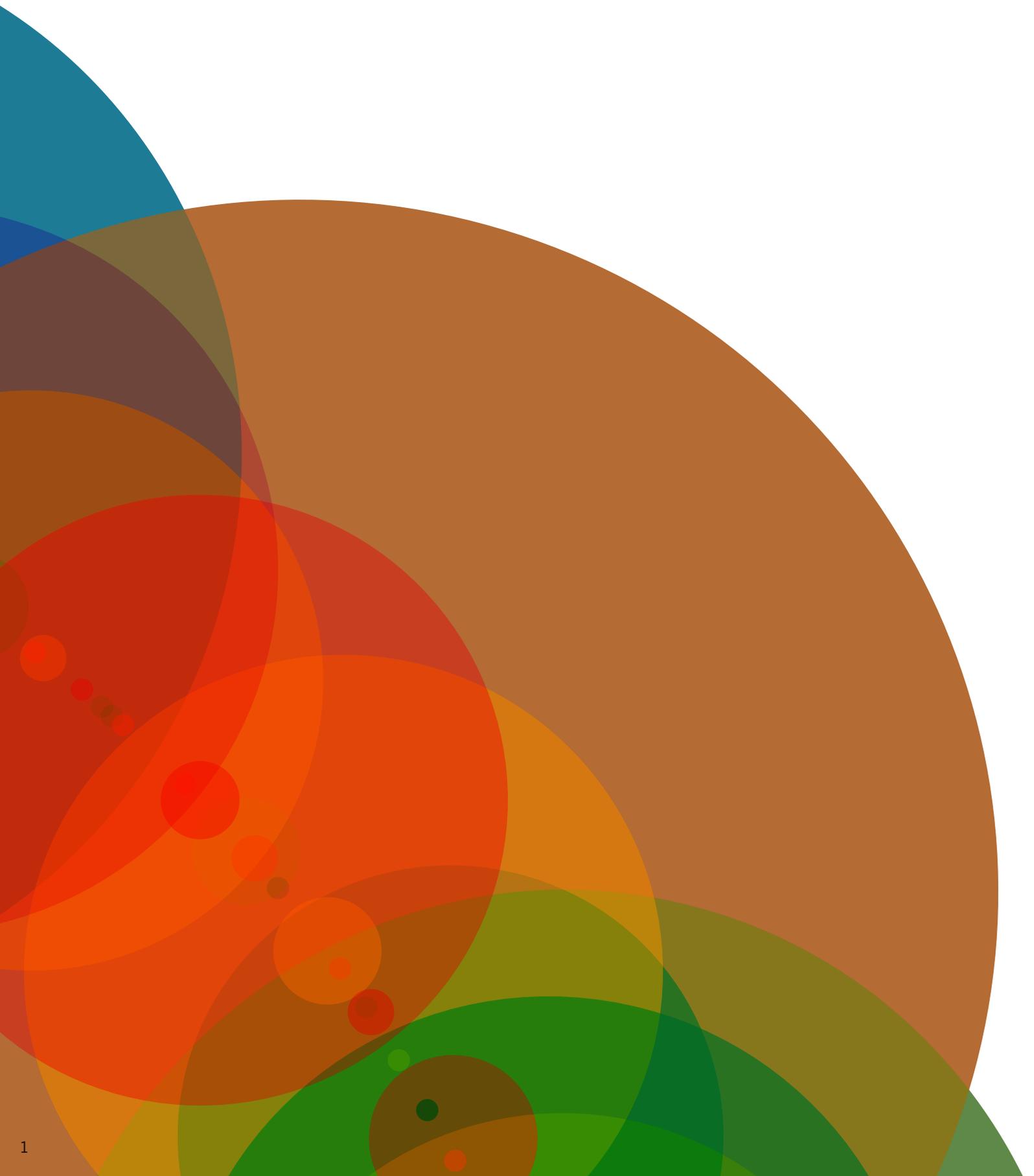
Considers specialisation across the institutions and areas of disciplinary strength for APRU, and how the different institutions within the network complement each other.

CHAPTER 5

Demonstrates how the network is stronger when it acts together by looking at collaboration and synergies between institutions.

1.

CONTEXT



1.1

Introducing APRU

The Association of Pacific Rim Universities (APRU) is an association of the presidents of 45 leading research universities across the Asia-Pacific region. The universities span 17 economies, building international cooperation, fostering talent, contributing to social and economic advancement and developing new knowledge on the major challenges facing the region.

APRU was established in 1997 by the presidents of the California Institute of Technology (Thomas Everhart), the University of California, Berkeley (Chang-Lin Tien), the University of California, Los Angeles (Charles Young) and the University of Southern California (Steven B. Sample).

Seeing the rapid economic integration of the region and the formation of APEC, the founding presidents' vision was to establish a premier alliance of leading research universities from around the Asia-Pacific region as an advisory body to international organisations, governments and business on the development of science and innovation as well as on the broader development of higher education. The vision now encompasses focusing new knowledge on the global challenges affecting the region.

Located initially in Los Angeles and then in Singapore, the APRU International Secretariat is now based in Hong Kong on the campus of the Hong Kong University of Science and Technology.

This work recognises the diversity present within the region as well as differences between the APRU institutions themselves.

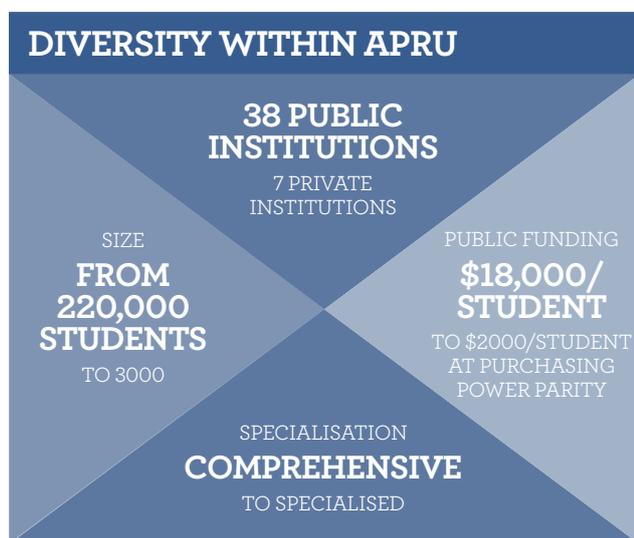


FIGURE 1: APRU contains a diverse range of institutions in terms of size, degree of specialisation and sources of funding

1.2

Asia-Pacific regional characteristics

The Asia-Pacific is a region of contrasts, in terms of demography, economic diversity and culture. The economies

within the region contain 40% of the world's population, 54% of global GDP and 44% of global trade.¹

This section looks at the socio-economic aspects of the region, alongside the geographical challenges and opportunities, and considers how these challenges affect higher education and research needs in the region.

1.2.1

Socio-economic characteristics

The Asia-Pacific region is one of stark contrast: APRU economies vary by two orders of magnitude in population between economies (Figure 3) - from New Zealand and Singapore to China and the US - and by one order of magnitude difference in GDP per capita.

Demography

AGE PROFILES, GROWTH AND DECLINE - Demographic change is probably nowhere more diverse than among Pacific Rim economies. The region includes economies such as Japan, with the highest proportion of elderly citizens in the world, and the Philippines, where over 50% of the population is under the age of 25 (Figure 2). The group also contains economies such as Hong Kong with a 'bulging middle', where a low current birth rate is insufficient to replace the middle-aged population. Other Asian economies are also facing a decline in fertility rates and their workforces are growing older. Due to the implementation of its one-child policy over the last three decades China will face a rapid ageing of its population in the next 20-30 years. Due to variations in birth rates and migration, the Asia-Pacific region contains economies such as Japan where population has been declining, and economies such as Singapore, Australia, Malaysia and the Philippines where annual population growth rates have hovered around 1.5% or higher (Figure 3).

INTERNATIONAL MIGRATION - At one extreme, Singapore and to a lesser extent Australia and Canada, see significant net influxes per year to their population. For Singapore such migration in 2007 was almost 10% of the total population.² At the opposite end of the spectrum, Mexico and the Philippines have seen net migratory outflows (in 2007 and 2012 in the range of 1-2% of the population).³

Population, by age group (2014)

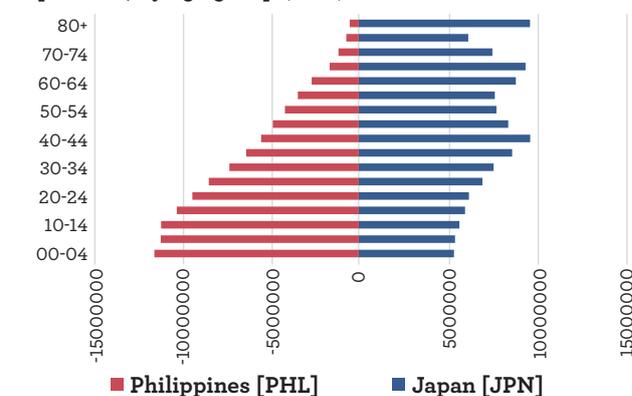


FIGURE 2: Contrast in population profiles for two APRU economies. Data: UIS Statistics

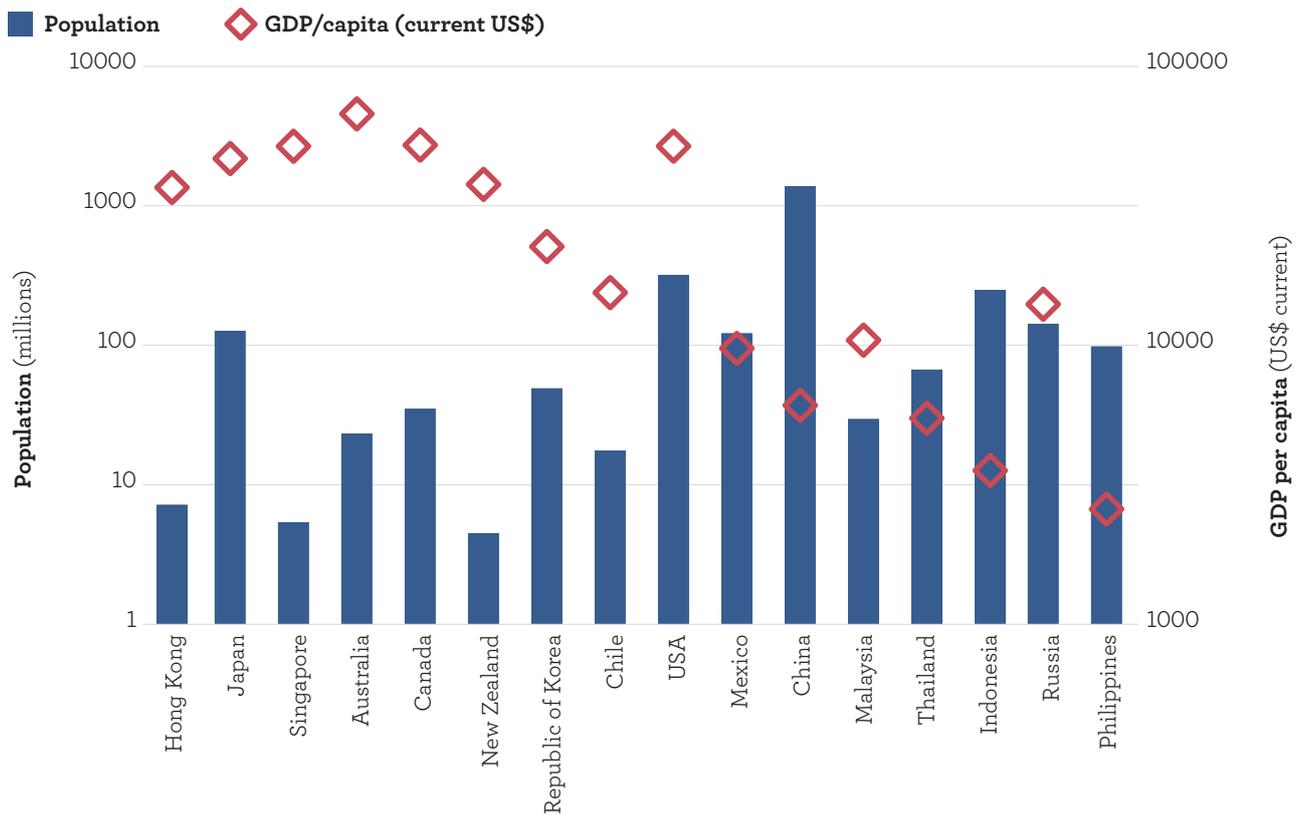


FIGURE 3: Disparity of population and population growth across APRU economies. Data: UIS [C]

URBAN MIGRATION - There is a growing urbanisation trend across the region, but with large differences between the member states concerned, from Thailand where the majority of the population (66%) is still rural,⁴ to Singapore which is an urban state. Rapid urbanisation has raised environmental and socio-economic challenges in some parts of the region. Some of the world's most densely populated cities, including Hong Kong, Singapore, Shanghai, Beijing, Taipei and Manila, are located in the Asia-Pacific with accompanying high levels of demand for basic needs and infrastructure such as water supply, human waste management and transport.

IMPACT ON & OF UNIVERSITIES: Demographic factors in the region have direct consequences for the education systems across the economies. Challenges vary according to whether the student age population is declining or growing; in a situation of growing demand for example, challenges include ensuring sufficient teaching resource to support the talent pipeline. Where applications to tertiary education are diminishing, it can also be a challenge to maintain quality and infrastructure in the face of economic pressures and a declining base over which to spread fixed costs.

In addition, changing population structures result in significant socio-economic challenges for the economies concerned, ranging from providing adequate healthcare support for ageing populations to integrating new immigrants into the community, and managing and mitigating the environmental impact of demands on resources. APRU institutions are actively

undertaking research and innovation to meet these challenges. With 40% of the global population and rapid economic development over the past 40 years, significant environmental pressure has been placed on the region. Challenges include an increase in the need for industrial waste management as the Asia-Pacific has become a manufacturing hub for the world, while changes to land use and deforestation have raised issues of air quality across national boundaries.

APRU institutions are actively researching challenges at the intersection of human health, development and the environment. For further information on the contributions of APRU and its institutions see page 19.

The religions of the world

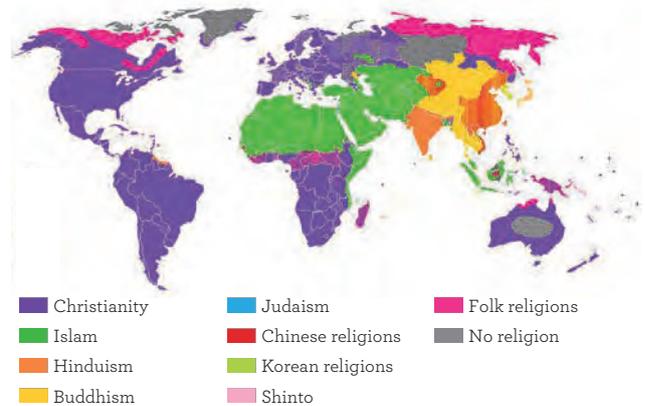


FIGURE 4: Religions of the world: dominant religions shown by economy. Source: Wikimedia commons

Cultures around the Asia-Pacific

The Pacific Rim is a confluence of different racial, cultural, ethnic, linguistic and religious groups. This diversity brings with it a variety of viewpoints and potential for increased adaptability and exchange of innovative ideas. At the same time, challenges of communication, both linguistic and cultural are to be expected.

IMPACT ON & OF UNIVERSITIES: Universities are highly connected internationally through faculty recruitment, collaborative research and the exchange of international students. As such they offer a cultural bridge across the region. With such a broad cultural base, universities around the Pacific Rim can act as melting pots, driving innovative research and learning and pushing both researchers and students alike to look beyond their comfort zone.

Economic diversity & trade:

Significant changes have occurred in the social and economic fabric of the region over the past 40 years. Economic output in Asia and the Pacific has quadrupled since 1990, with development largely driven by economies adopting export-oriented industrial development strategies.⁵

Asian economies are still predicted to have some of the highest rates of GDP growth globally in the next 10 years. Asia-Pacific economies are deeply involved in global goods production and international trade routes. In 2014, Singapore and Hong Kong, goods traded represented more than three times the value of the GDP of the respective nations.⁶

In Korea, China, Mexico, Singapore, Malaysia and Thailand, each country's exports contain more than 30% foreign gross value added,⁷ demonstrating how interconnected these

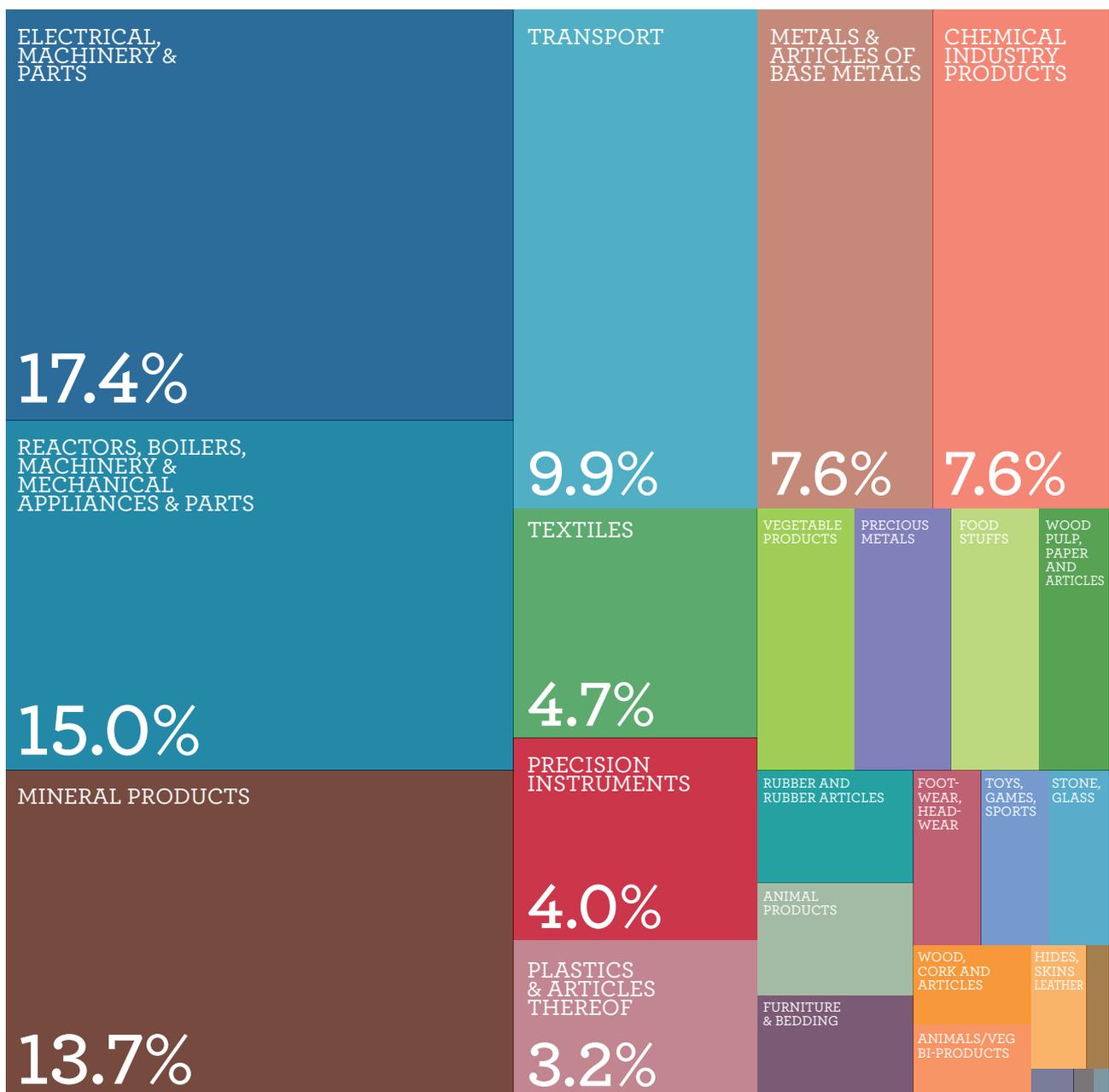


FIGURE 5: Exports of APRU economies by type, as a % of total export value (US\$). Data: Atlas of Economic Complexity [L]

economies are within the global value chain. Knowledge transfer of state-of-the-art technologies and processes is necessary if local businesses are to retain their competitiveness and continue to capture value for their economies.

IMPACT ON & OF UNIVERSITIES: Collectively APRU institutions offer research strengths in areas of high importance for the exports of APRU economies (such as materials science). Niches in research competencies (such as semiconductors) are often linked to an area of competitive advantage of the economies concerned. Industry and academia are self-reinforcing, as state-of-the-art research enhances industry competitiveness and increases local demand for research in the area.

1.2.2

Geographical challenges and opportunities

Living with the risk of disasters

The region faces unique challenges related to its geography. Due to the configuration of the tectonic plates around the world, the Pacific is surrounded by the 'Ring of Fire'. It is so named for the volcanoes and seismic activity that occur at the plate boundaries, including many subduction zones, where one plate is pushed below another (Figure 6). Globally, about 90% of all earthquakes occur along the Ring of Fire, and it is dotted with 75% of all active volcanoes on earth.⁸ Living with these geophysical hazards is a significant and specific challenge for the region.

Asia-Pacific economies can also be vulnerable to climate hazards such as cyclones, hurricanes, typhoons, landslides and large-scale flooding. Multiple hazards may be present in one area. Chinese Taipei for example, experiences earthquakes, typhoons, landslides and floods due to its geology and climate.

Growing urban populations in the region increase the potential impact of any one event, raising the overall risk of loss of life and infrastructure. In terms of risk and vulnerability, the Philippines has recently been identified by the United Nations as one of the most at-risk nations on the planet.⁹

IMPACT ON & OF UNIVERSITIES: The presence of natural hazards in the region drives research in the field, partially for societal reasons and also as proximity enables detailed study. Chapter 3 discusses in detail the contribution of APRU to disaster risk reduction.

Pacific Ocean – climate change, fishing, ocean biodiversity

The Pacific is the world's largest ocean (covering 46% of the earth's water surface and 28% of its total surface) and plays an important role in its climate. On a global scale, the Pacific is believed to play a role in moderating the effects of rising CO₂ levels in the atmosphere. Asia-Pacific regional phenomena of climate variability, such as the El Niño – Southern Oscillation (ENSO), are some of the best-known examples of decadal variation (Figure 7). This ENSO cycle is associated with changes in temperature and precipitation, leading to significant regional impacts.

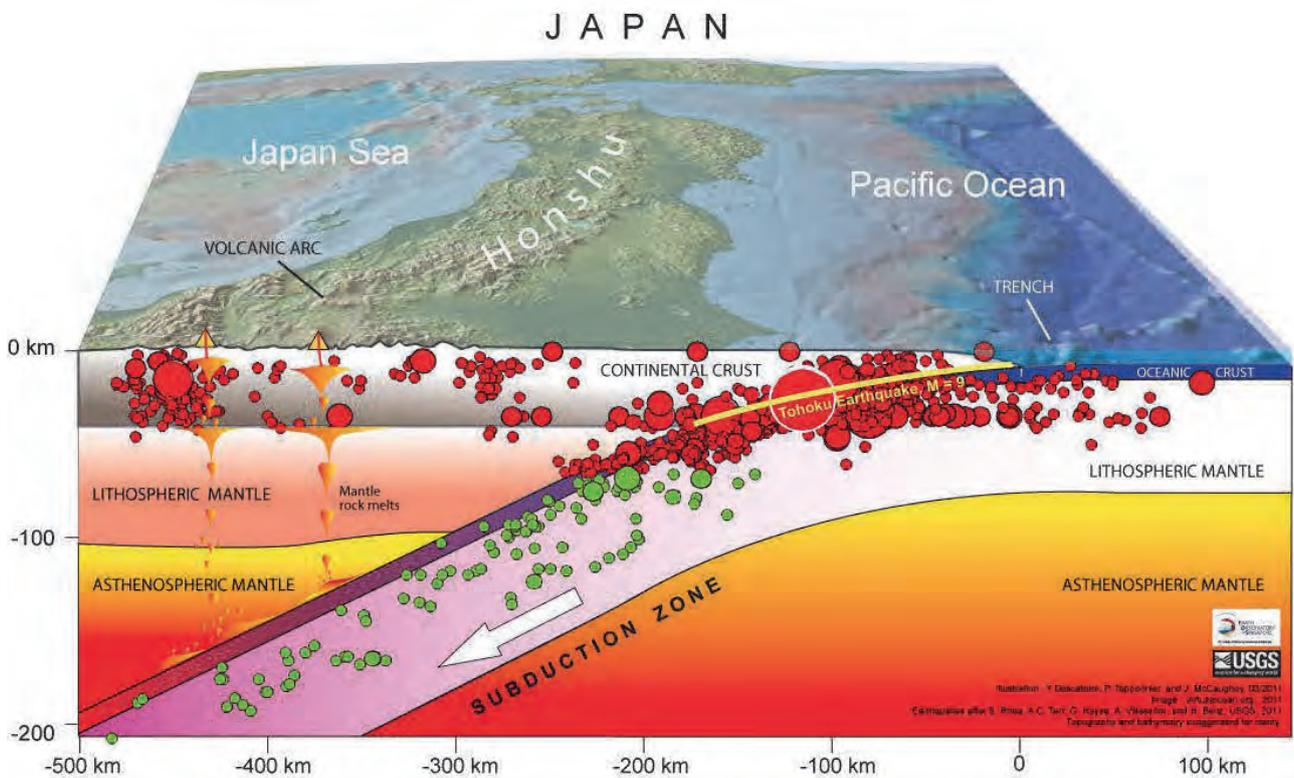


FIGURE 6: Geophysical hazards: location of Tohoku earthquake (2011) and graphic of the surrounding subduction zone. Source: USGS & Earth Observatory of Singapore.

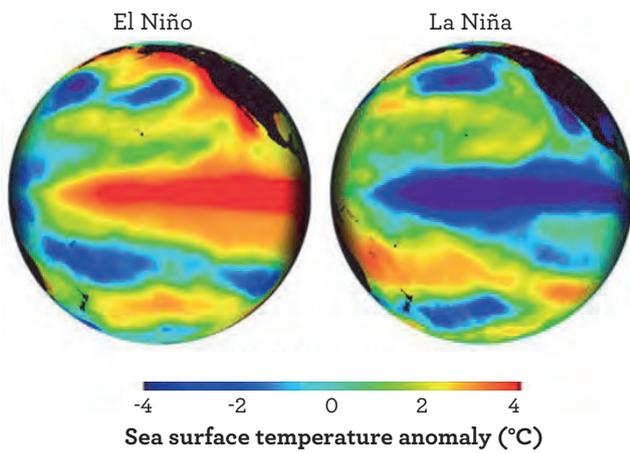


FIGURE 7: Differences in sea surface temperature between El Niño and La Niña phases. Source: National Oceanic and Atmospheric Administration (NOAA), USA

The Pacific offers a rich resource for fishing, representing approximately 60% of the world’s annual fish catch,¹⁰ with more than 25,000 islands,¹¹ and extensive coral reefs and biodiversity. Pacific Rim challenges include ocean governance, sustainable management and protection of this marine biodiversity.

IMPACT ON & OF UNIVERSITIES: APRU institutions collectively demonstrate strength in research related to global planetary change and atmospheric science as shown in Section 4.1.1.

1.2.3

Higher education conditions in the region

Investment in education varies significantly by economy in the Asia-Pacific region. This section explores government investment, overall access rates to education, provision by private providers and evidence of demand or need for graduates (via the proxy of wage premiums obtained by university graduates).

GOVERNMENT INVESTMENT IN EDUCATION – Singapore has seen one of the most dramatic rises in prioritisation of education from the late 1990s to the present, with 7-8% of government expenditure now allocated to the sector.¹² In contrast, many of the economies in this study have seen some decline in relative prioritisation of public spending on education over the same period, including the USA, Thailand and the Philippines.

FUNDING HIGHER EDUCATION – In most economies funding per tertiary student has remained relatively static in real terms. The US has seen some decline, albeit from a comparatively high level. Japan faces a different issue related to demographics: due to a declining tertiary-aged population funding per student is in effect rising, as fixed costs are spread over a smaller base.¹³ The range in public funding per student across APRU economies is shown in Figure 8, measured in terms of purchasing power parity (PPP) in the respective economies.

ACCESS TO TERTIARY EDUCATION – Funding trends are occurring against a background of increased access to education across all APRU economies as universities are expected to deliver education to an increasingly diverse student population. A disparity still exists between the level of

enrolment for the tertiary-aged population, with a near 100% enrolment rate in Korea and a rate of less than 30% in China in 2012. Nevertheless, China and Chile have seen some of the most rapid rises in enrolment ratios (in the case of China from less than 10% in 2000 to around 30% today).¹⁴

PRIVATE PROVISION IN TERTIARY EDUCATION –

In Australia, at one extreme, 91% of tertiary education is delivered by public providers. New Zealand, Russia, Thailand

Funding per student (US\$, PPP), average 2010-2012

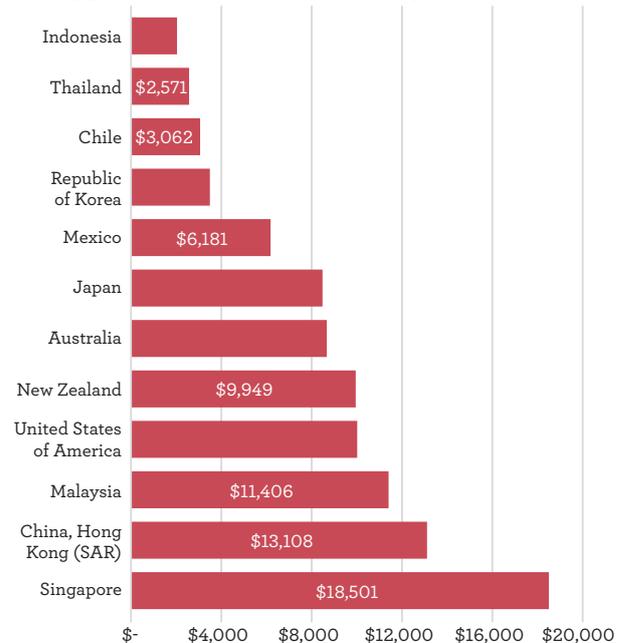


FIGURE 8: Differences in funding per tertiary student by economy (at purchasing power parity). Data: UIS [C]

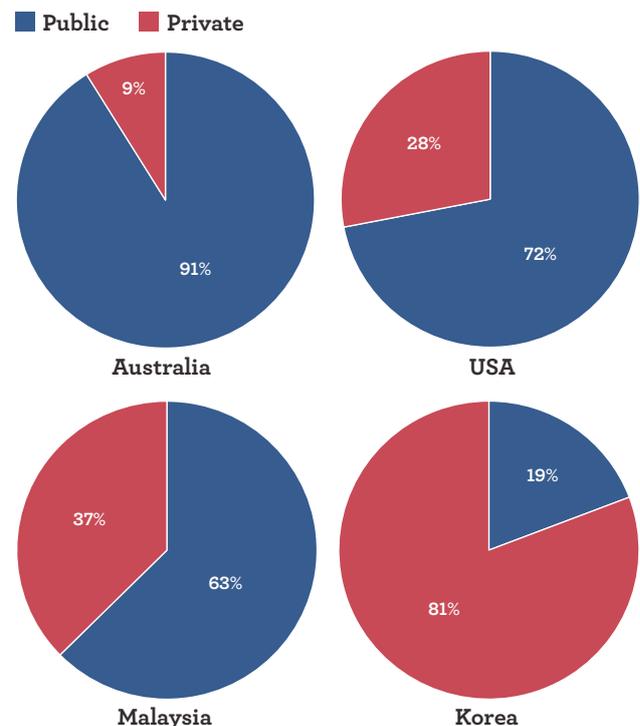


FIGURE 9: Provision of tertiary education by the public and private sector, showing variation by economy. Data: UIS [C]

and Hong Kong see similar levels of public provision. In Korea, Japan and Chile, by contrast, over 75% of students are enrolled in private institutions. The USA and Malaysia represent intermediary examples with substantial public and private provision.¹⁵

EVIDENCE OF TERTIARY EDUCATION DEMAND -

Across the economies shown in Figure 10 wage premiums are observed for higher education, supporting the value placed on such education by employers. In the US for example, salaries for those with tertiary education are around 180% of those with upper secondary education alone. Even sharper contrasts are seen in some ASEAN nations.¹⁶

TERTIARY STUDENT MIGRATION - High quality educational systems play an important role in retaining and attracting talent for the Asia-Pacific region. Universities in some economies are not only fulfilling a local educational role but also an Asia-Pacific regional one. Institutions in Australia,

Relative earnings from employment, by level of educational attainment (latest available year)

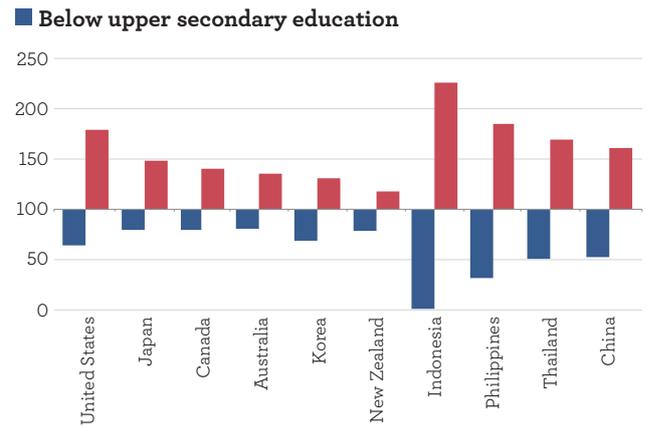


FIGURE 10: Value placed on tertiary education, evidenced by earnings from employment relative to secondary education (2009 or latest year available). A value of 100 is equal to the average earnings of those with upper secondary education. Data: OECD [G]

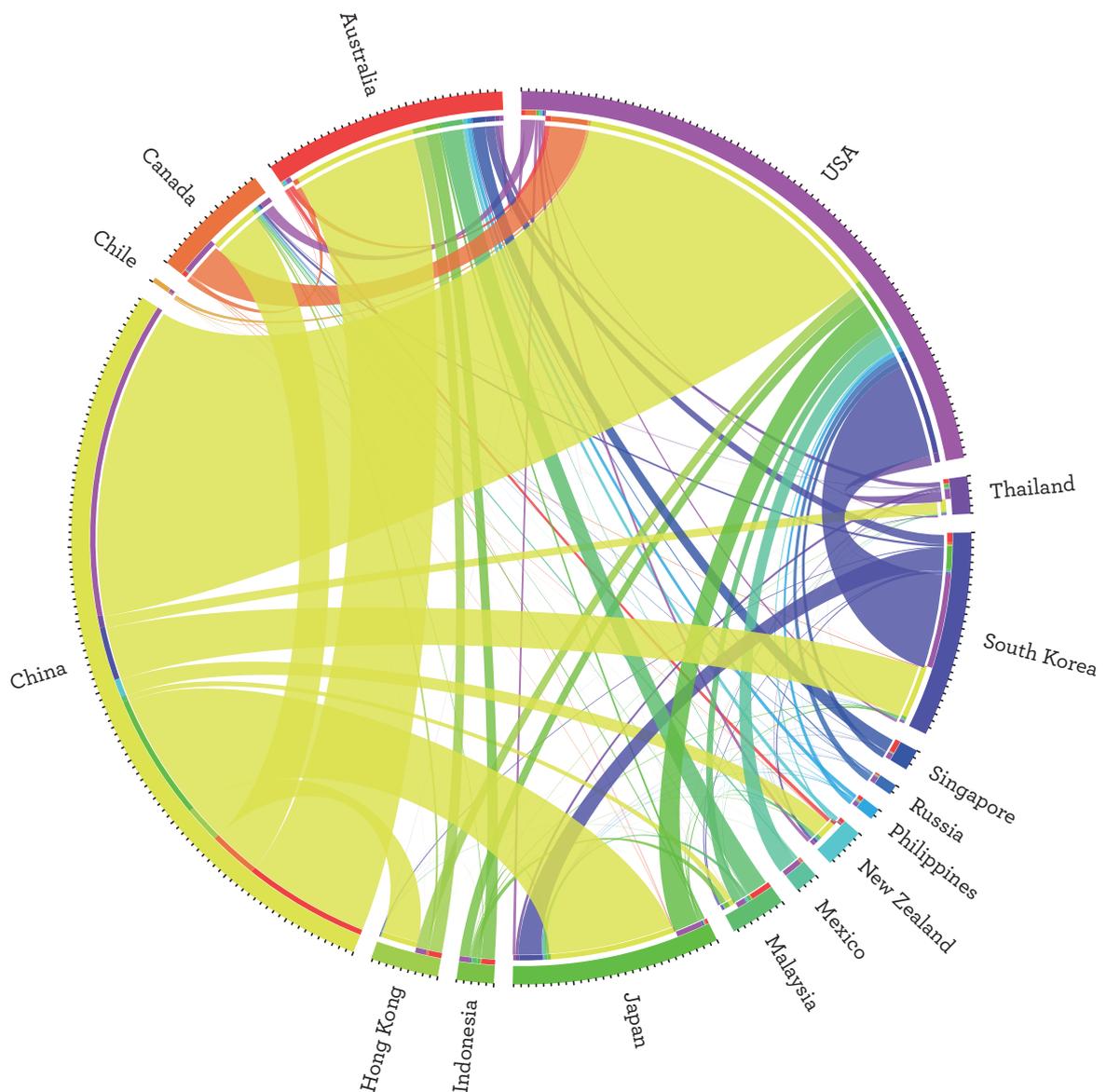


FIGURE 11: Migration of tertiary education students around the Asia-Pacific, with major flows from China. Volume proportional to thickness of line, colour reflects economy of origin. Influx data missing for China, Singapore, Russia. Data: UIS [C]

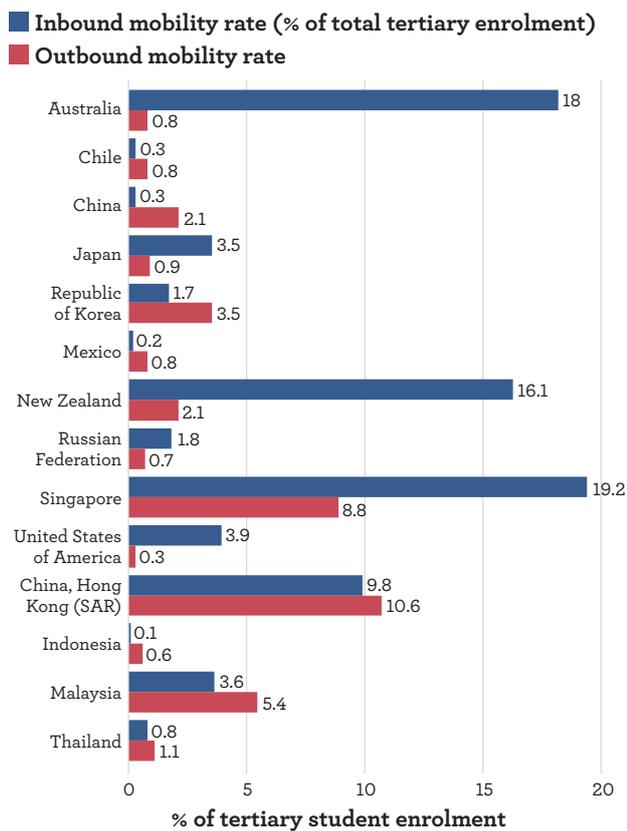


FIGURE 12: Tertiary education inbound & outbound rates by economy, as a percentage of total tertiary enrolment. Australia, New Zealand and Singapore have notable influxes as a proportion of the total. Data: UIS [C]

New Zealand and Singapore have a significant influx of students for the size of their tertiary systems (Figure 12).

Migratory flows of students can assist with fulfilling educational needs, particularly with the demands of a growing or declining student population. In the majority of APRU economies the dominant flows of international students are to other Asia-Pacific nations.¹ In volume terms, students from China can be found in large numbers studying in the US, Japan, Australia, Canada and to a lesser extent Korea (Figure 11). The US also receives a significant influx of Korean students.

The role of APRU institutions in tertiary migration and in forming cultural bridges throughout the region is discussed in detail in Chapter 2.

1.2.4

Demand for and investment in research and development in the region

Public & private expenditure on R&D

The level of investment in research shows significant variation across economies in the Asia-Pacific (Figure 13). At one extreme, Korea has both high business and high public expenditure on R&D (approximately 3% and nearly 0.9% of GDP respectively in 2013); conversely economies such as the Philippines and Thailand have low public and low private spend. In some economies, notably Canada, New Zealand, Singapore and Australia, R&D conducted by the public sector is proportionally high.

While in many economies business expenditure on R&D exceeds that of public expenditure, the two often rise with each other as two components in one ecosystem fulfilling different roles. Universities are for example able to take a longer view on their research portfolio, conducting work considered to be too risky or early-stage for a company requiring short term return for its shareholders. For further discussion of the role of universities in the innovation ecosystem see Chapter 2.

Private funding of university research

Typically, between 5% and 10% of research in universities is financed by industry. Korea, Russia and China buck this trend – approximately 35% of higher education research carried out in Chinese universities is funded by the private sector.

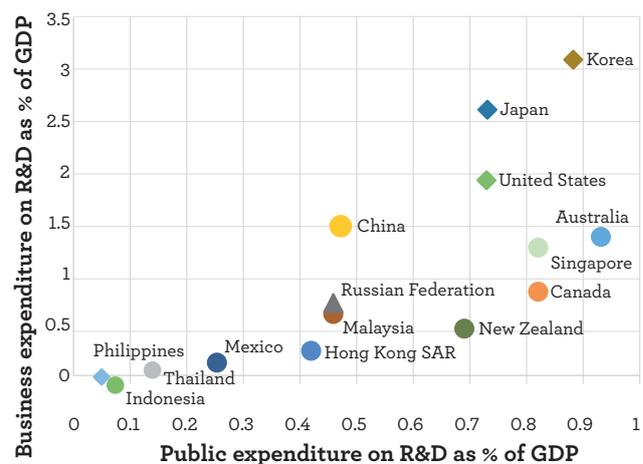


FIGURE 13: Public and private expenditure on R&D is variable between the economies and is typically positively correlated (Data: 2012 or latest year). Public expenditure includes both universities and government research institutes. Data: UIS [C]

1.3

Response to research and education conditions

Depending on local conditions (discussed in Chapter 1), including available funding, the presence of other institutions, and the socio-economic needs of the surrounding community, universities take decisions regarding their:

- societal roles and particularly how they balance education, knowledge creation and innovation, and translation activities, which often compete for human resource,
- choices to specialise or to offer breadth,
- focus within each of these roles (such as the choices of educational offerings including bachelor's, master's, PhDs or professional degrees and courses, and their emphasis on certain disciplines),
- emphasis on local and global issues.

In some cases such decisions are taken strategically; in others they develop organically in response to surrounding demand. Chapter 2 looks at the different roles and the impact of APRU institutions in each of these areas.

¹ While Russia and the US have larger fluxes outside the region, predominantly to Europe.

2.

ROLE AND IMPACT OF APRU UNIVERSITIES IN THE ASIA-PACIFIC REGION



Universities are under pressure globally to fill a widening range of roles in today's world. More than ever there is an increasing demand for universities to act as economic engines driving local economic growth. Contributions to economic development often dominate the discourse including metrics surrounding spin-out companies, patents and other intellectual property (IP). However, while universities have a role to play in innovation and knowledge transfer, they offer many more contributions to society.

This chapter takes a holistic view of the roles APRU universities play in the Asia-Pacific region to represent the diversity within each institution as well as across the region. The roles considered are summarised in the diagram below. These are not intended to be prescriptive or exhaustive but to give a flavour of the variety of impacts observed. APRU institutions and APRU initiatives:

- **Educate** millions of students each year, with over 1.7 million enrolled students and extensive alumni networks the impact of the APRU network is substantial
- **Create** new knowledge, producing world-leading research at double the rate compared to the world average

- **Connect** local stakeholders to global knowledge and to each other and build cultural bridges throughout the region
- **Apply** research to societal challenges – delivering real impact in areas such as health and sustainability
- **Innovate** – applying knowledge in new ways, to create revenue and business opportunities from IP
- **Act** as agents of change – inspiring critical debate, testing and enabling the roll-out of new ideas

This chapter will explore each role in turn, offering case study examples where APRU or APRU institutions continue to provide significant contributions and impact. Individually APRU institutions emphasise and offer different strengths, and collectively the impact of the group is greater than the sum of the parts through sharing of best practices, exchange of knowledge and collaboration.

Navigation in the document

To aid comprehension, subsequent sections of this report are colour-keyed in the header according to Figure 14, depending on the role being discussed, thus (for Educators):



A grey header means the topic is general and not role-specific.



FIGURE 14: Roles and impact of universities in the Asia-Pacific region.

2.1

Educators and capacity builders

Universities have education at their core, and one of the largest impacts a university can have is through its students. Here we examine the impact of universities as educators, not only directly through their students and alumni but also for wider society. The role includes:

- A. Enabling alumni to work effectively in an increasingly complex, dynamic and technological world, including supporting the development of skills to *interpret* through critical thinking and logic, and to *communicate* effectively.
- B. Training professionals (including doctors, engineers, lawyers, teachers and others) to serve their communities.
- C. Educating tomorrow's leaders; many APRU alumni have gone on to play key roles nationally, regionally within the Asia-Pacific and globally.
- D. Offering pathways to a fairer and more cohesive society, enabling social mobility and providing a diversity of successful role models.

Universities also have a role to play in society by helping today's citizens question, understand and process evidence on complex issues to enable informed decision-making. This includes more specific activities building scientific literacy and cultural awareness. This impact materialises in part through graduating students, and by supporting continuing professional development, but can also be augmented by other activities such as public engagement in research, outreach activities such as public lectures and open days, and contributions to traditional media. Thus there is another potential role for impact:

- E. Educational outreach, raising scientific literacy, cultural awareness and encouraging public debate through a range of avenues (including public talks, social media and outreach activities).

A. APRU – valued students, ready for the workforce:

As evidenced in Chapter 1, the region has seen strong growth in access to higher education with a higher percentage of tertiary-aged students attending university than ever before. APRU institutions have been educating more graduates while maintaining quality and output in research and other activities. Today over half a million students per year graduate from APRU institutions.¹⁷

GLOBALLY EMPLOYABLE: APRU institutions produce highly valued students as evidenced at a local level by the demand for graduates and premiums for tertiary-educated workers. In the OECD countries for example, a person with a tertiary education can expect to earn 55% more on average

than a person with an upper secondary or postsecondary (non-tertiary) education.¹⁸ In 2015, seven APRU institutions were in the top 20 institutions in the Times Higher Education (THE) Global Employability University Ranking.¹⁹

Leaders in continuing & online education

Universities also now reach a global audience of students through massive open online courses (MOOCs) and YouTube channels. MOOCs allow individuals to explore new areas at low cost; access barriers are low for students from countries or regions without courses in the topic. Online delivery reaches larger audiences than physical institutions. For example, 17,000 students registered for Hong Kong University of Science and Technology's (HKUST) first MOOC²⁰ and today Coursera (one of the larger online platforms) claims 10 million users.²¹

APRU institutions were early leaders of the online course movement; Stanford courses began in 2011, Berkeley was also an early adopter (with a focus on free provision), while HKUST was an early pioneer in Asia. Today 32 APRU institutions now offer over 654 online courses (as of 1 January 2016), many of which are free, while others grant credentials typically charging a small fee. Peking and Stanford are leading institutions globally in terms of numbers of MOOCs offered.²²

STUDY 1

Preparing future-ready graduates

Maximising Student Potential and Realising their Aspirations, Short- & Long-term, National University of Singapore (NUS)

CONTEXT: Investment in human capital through education and training has been at the heart of Singapore's progress and has helped citizens to develop and maximise their potential. Students at NUS are being prepared for a faster-paced future, with skills and qualities that increase adaptability as well as job-related skills. These include critical thinking, intellectual breadth, cross-cultural effectiveness, communication skills, and personal qualities such as initiative, resilience, inclusiveness/teamwork, and integrity.

INITIATIVE – PREPARING NUS GRADUATES:

Rigour, critical thinking and a distinct global-Asian approach are fundamental to NUS' teaching. Other initiatives include technology-enhanced learning (iBLOCs), a grade-free first semester system (to avoid students selecting subjects for grade optimisation) and, in 2015, a new general education framework. Careers advice is enhanced through the Centre for Future-ready Graduates and project-based learning and compulsory internships have been extended.

INITIATIVE – CONTINUING PROFESSIONAL EDUCATION: A new School of Continuing and Lifelong Education (or SCALE) was established in January 2016 to help alumni and Singaporeans skill and re-skill for existing or new jobs. This is to help students and alumni to remain agile and responsive to change throughout their careers, and to serve Singaporeans as part of the national SkillsFuture drive. The school offers certificates, diplomas and degrees, with many courses online and accessible to a global audience. Additionally, an Institute for Application of Learning Science has been set up to lead in translating learning science to practice, so as to optimise the educational experience and outcomes.

EVIDENCE OF SUCCESS: In the recent THE Global Employability University Ranking 2015, NUS graduates were among the most sought-after by employers. NUS was placed 17th in the world in a global ranking that measures how universities perform on graduate employability, up from 39th place in 2014, and was the only Singaporean university in the world's top 20.

Leaders in a Digital World, Tecnológico de Monterrey (Tec)

CONTEXT: Skills development is key to improving productivity. Tec has developed innovative programs for Continuing Education that incorporate the latest trends in educational technology and adult education to grow key skills and to provide comprehensive solutions for organisations. Technologies include gamification (elements of game-play), MOOCs (massive open online courses), digital environments, virtual reality, and flipped classroom (where initial exposure to new ideas is gained outside the classroom).

ASIA-PACIFIC REGIONAL AND COMMERCIAL INITIATIVES: As an example of an open program in this vein, 15 participants from different countries are successfully participating in the Latin American Innovation Challenge to design high-tech products.

Tec has designed a strategy along with partners such as Coursera, EdX and MéxicoX to create MOOCs on key topics which respond to the needs of the Latin American region, including entrepreneurship, data and analytics, family business and digital marketing.

OUTCOMES: The current offering of MOOCs includes certifications in partnership with leading companies such as IBM, who evaluate – collaboratively with Tec – the performance and results of the participants. This guarantees the proper development of specific skills required by organisations in the Latin American region.

This work has capitalised on Tec's strengths in designing and delivering 'Corporate University' initiatives in Latin America, Mexico and Europe in sectors such as manufacturing, banking and finance, energy, and government.

B. APRU: training professionals and higher level graduates

APRU institutions play a key role in providing doctoral degrees and professional practice degrees (including training medical professionals, lawyers, veterinarians and dentists). In states such as California for example, APRU institutions produce nearly half of all professional graduates. In settings such as Hawaii where the variety of providers is less, they play an even stronger role, delivering up to 70% of all professional graduates.²³

APRU Global Health Program has taken a lead in the development of recommendations and guidelines for global health education and training (as described in Study 2).

STUDY 2

Professional education: building capacity, sharing best practice

Development of Recommendations & Guidelines for Global Health Education and Training, APRU Global Health Program, led by University of Southern California (USC)

CONTEXT: Academic institutions have a key role in training a competent global health workforce and in preparing leaders to address health issues. However, little agreement exists on what constitutes appropriate global health training. The APRU Global Health Program works to address such issues in global health education, under the leadership of USC.

COLLABORATION: Multi-economy teams under the Global Health Program have worked together to:

- i. develop a set of best practices in global health practicums for universities,
- ii. create a set of recommendations regarding global health core competencies for universities,
- iii. outline the rising demand for postgraduate global-health-focused education and training in the Pacific Rim region, based on a survey of APRU member universities.

TEAM MEMBER INSTITUTIONS INCLUDE: NTU (Chinese Taipei), NUS (Singapore), U. of the Philippines, Seoul National University, U. of Auckland, U. of California, Irvine, U. of Sydney, U. of Tokyo.

PUBLICATIONS INCLUDE: "Training the next generation of global health experts: experiences and recommendations from Pacific Rim universities," Journal: Globalization and Health, 2016 [in press].

Training and Education of Mental Health Professionals, University of Melbourne (UoM) and Peking University (PKU)

CONTEXT: Mental health disorders make up approximately 13% of the world's diseases and are one of the largest contributors to all diseases. By 2020, depression will be the leading contributor to global burden of disease.

COLLABORATION: UoM and PKU established a joint Centre for Psychiatry Research and Training in 2014, to extend research links. The centre promotes academic research, academic exchanges and educational collaboration.

INITIATIVE: Building mental health capacity: In China some 200 million people suffer from mental health issues. The Chinese government asked PKU Institute of Mental Health to lead in doubling the number of medical doctors trained in psychiatry – 80,000 by 2020. UoM and PKU are delivering an advanced training program that uses blended learning.

INITIATIVE: Supporting the largest program of mental health reform seen globally. Since 2003, UoM's Asia Australia Mental Health has been the key international partner in China's national mental health reform program, the so-called '686 Project'. This project is one of the largest mental health reform programs globally, delivering community psychiatric services to a population of 940 million. The two universities have partnered closely in the national roll-out of training to support modern community mental health services across China.

"We work now as one team, not Chinese, not Australian but a team that understands each other's strengths and needs and is focused on improving the lives of the most neglected in all populations – people with mental illness." Professor Ma Hong, Director, Department of Public Mental Health, Peking University Institute of Mental Health.

INITIATIVE: Sharing best practice across the region: Myanmar only has 207 psychiatrists for a population of 53 million and depression is a major public health issue. In 2015, PKU and UoM colleagues worked with the Myanmar Psychiatric Association to deliver a joint symposium in Yangon for 62 psychiatrists and trainees. The aim was to facilitate sharing of advances in depression assessment and treatment, especially in low- and middle-income countries.

"Thank you for organising the trilateral collaboration ... Our first step, this training workshop was very fruitful and successful ... I look forward to strengthening our trilateral collaboration in future." Professor Win Aung Myint, Head of Department of Mental Health, Mental Health Hospital, Yangon, Myanmar.

New Legal Programs to Meet New Demands – Connecting Legal Professionals, University of California, Irvine (UCI)

CONTEXT: Following the 2007 changes to legal education and the legal services market in South Korea, the rules have changed for Korean lawyers and law schools. Schools are being evaluated on new metrics designed to encourage greater internationalisation and global impact, measured by courses, publications and global partnerships. Lawyers are increasingly required to understand the US legal system to address the needs of their clients.

Likewise, the legal profession in the United States faces similar demands for globalisation. Southern California, for its geographic and cultural proximity to East Asia, has been a hub for US-Korea legal and commercial transactions. For this reason, the UCI School of Law is well positioned to serve the needs of the local legal community that does business with Korea and be an effective partner to Korean lawyers and institutions with an interest in the US legal market.

INITIATIVE: UCI created the Korea Law Center to provide the knowledge transfer, exchange and collaborations needed between law firms and policymakers in the US and Korea. The centre acts as a cultural bridge, helping local Korean partners meet the needs of their local stakeholders in Korea while simultaneously connecting US attorneys with information they need to serve their clients in California.

OUTCOMES: In 2009 the UCI Law School began hosting legal professionals from Korea to study the US legal system and engage with local Californian attorneys whose law practices reach Korea. UCI has since hosted nine law professionals from the Ministry of Justice, six from the Constitutional Court and five law professors from the Supreme Court (and plans to host seven visiting scholars in the 2016-2017 academic year). The UCI Korea Law Center and one of its partners, Korea University Law School, are planning to co-host a symposium in 2017.

C. Educating tomorrow's leaders

APRU institutions have long played an important role in educating global leaders; some examples of alumni of APRU institutions are included in the table below.

	Location/role	Name	APRU institution
Prime ministers and Presidents	Japan (current) Canada (current) Australia (current) Chile (current, and 2006-2010) Mexico (current) Malaysia (1981-2003) Singapore (1959-1990) Singapore (1990-2004) Chinese Taipei (current) People's Republic of China (current & 2002-2012) South Korea (2008-2013)	Shinzo Abe Justin Trudeau Malcolm Turnbull Michelle Bachelet Enrique Pena Nieto Mahathir Mohamad Lee Kuan Yew Goh Chok Tong Ma Ying-jeou Xi Jinping & Hu Jintao Lee Myung-bak	USC U. of British Columbia U. of Sydney U. of Chile Tec (Monterrey) NUS (U. of Malaya) NUS (U. of Malaya) NUS NTU Tsinghua University Korea University
Intergovernmental leadership	UN Secretary General (current) President International Criminal Court (2009-2015) Administrator of UN Development Program (& New Zealand Prime Minister 1999-2008) Managing Director and COO of World Bank Director General of World Health Organisation	Ban Ki Moon Song Sang-hyun Helen Clark Sri Mulyani Indrawati Margaret Chan	Seoul National University Seoul National University U. of Auckland U. of Indonesia NUS
Business leaders	Samsung Electronics CEO Apple co-founder Intel Corp. co-founder HSBC Chairman (2005-2010) Google co-founders Hitachi CEO LG Group chairman Toyota Motor Corporation, President and CEO Sony Corporation founder	Kwon Oh-Hyun Steve Wozniak Gordon Moore Vincent Cheng Sergey Brin & Larry Page Hiroaki Nakanishi Koo Bon-Moo Akio Toyoda Akio Morita (1921-1999)	Seoul National University UC, Berkeley UC, Berkeley U. of Auckland Stanford University Stanford University Yonsei University Keio University Osaka University

APRU proactively supports the development of leadership at the undergraduate level through the **Undergraduate Leaders Program (ULP)**, a one- to two-week scheme with 40-60 students from across disciplines. Program activities include theme-related lectures and seminars with cultural and social activities. These activities are designed to help develop leadership skills and competencies. Themes vary by year depending on the host institution.

Almost half of world leaders today have international education or work experience,²⁴ the value of which has been highlighted by those surveyed. Schemes like the ULP, together with more general student exchange and activities, are helping to develop the next generation of leaders.

D. Building a fairer more cohesive society

Education provides a route for social mobility based on merit for people from diverse backgrounds, providing the opportunity for individuals to achieve higher earning potential irrespective of family history. Enabling access to higher education for those from backgrounds where a parent has not previously attended university and from under-represented groups within society is an area where APRU institutions have taken initiative.

Universities also have potential to set examples for other organisations with respect to building a more representative, fairer society. This includes, for example, improving

representation of women in leadership and supporting female role models for future generations. APRU has taken a leadership role here through the **Asia-Pacific Women in Leadership** program (described in more detail in Study 3).

STUDY 3 Building a fairer, more cohesive society

Leading by Example, University of Auckland (UoA) & Asia-Pacific Women in Leadership (APWiL) Program

CONTEXT: At UoA, although around 50% of academic staff members are women, only a third hold senior academic positions (the national average is 25%).²⁵ Rectifying such imbalances within our APRU universities is crucial for capacity building, developing the next generation of leaders, and increasing sensitivity to gender equity.

INITIATIVE: UoA offers the most comprehensive suite of Women in Leadership Programs in New Zealand to develop leadership potential. These include seminars, workshops, networking and mentoring for mid-career women. Opportunities to learn from leaders are provided for senior academic and professional women. Senior women are also

supported to participate in the annual National Women in Leadership week-long residential course, where they can meet other academics and public figures.

COLLABORATION: APRU supports member institutions to implement similar programs. UoA's Deputy Vice-Chancellor (Strategic Engagement) is co-Chair of the APRU APWiL Core Group. Since 2013, the group has published two reports: the APRU Gender Gap Survey and Report, and a report on the 2014 APWiL Special Workshop held in Tokyo, which includes the Shinagawa Proposal to improve the status of women in higher education in Japan. In April 2016, an APWiL Policy Round Table, co-hosted by UoA and the University of Hong Kong (HKU), was attended by delegates from 16 APRU institutions and has resulted in a series of policy recommendations.

Aboriginal and Torres Strait Islander Integrated Strategy, University of Sydney

CONTEXT: The University of Sydney introduced the Wingara Mura – Bunga Barrabugu Strategy in 2012, making Aboriginal and Torres Strait Islander education, research and engagement one of the University's core objectives. It defines the University's commitment to building opportunity, capability and rights for indigenous peoples, and for valuing their culture at the University.

INITIATIVES: Australia's first Deputy Vice-Chancellor Indigenous was appointed in 2011 to oversee the strategy. Initiatives include: academic support for indigenous students, an alternative entry program, support for mature students, academic skills for new students, leadership skills for indigenous staff, an Aboriginal and Torres Strait Islander Research Network, and high school participation programs.

OUTCOMES: The strategy has already produced significant results. Between 2011 and 2015, the number of indigenous students commencing at Sydney increased by 20% and Aboriginal and Torres Strait Islander staff numbers almost doubled. Sydney leads the Group of Eight universities in the number of indigenous graduates.

E. Raising scientific literacy & cultural awareness

APRU institutions produce educational resources for teachers to develop students' scientific and health literacy; example schemes include Berkeley's "Understanding Science" and University of Auckland's LENS Science programs. The latter is an innovative scheme involving partnership between schools, pedagogical experts and scientists. It includes specialist classrooms at the university where students and teachers have direct access to active research scientists; 5,000 students pass through each year. Online resources enable the work to spread throughout New Zealand and to the Pacific Islands.²⁶

Museums and libraries are curated and maintained and made accessible to the general public; examples include the Museum of the University of Tokyo where the 'Intermediatheque' exhibition space has received over 1.2 million visitors in two years, and the library at University of California, Berkeley which is the fourth largest university library collection in the US at over 11 million volumes.²⁷

APRU institutions each host a variety of public outreach activities such as public talks. The universities are also involved in specific outreach around societal challenges (for further examples see Chapter 3, Study 17).

2.2 Creators and maintainers of knowledge

Universities foster curiosity, offering places for independent thought, and typically enable a longer-term research view. As such they have a fundamental and unique role to play as hypothesis generators, data interpreters and overall knowledge creators.

- A. Universities are able to conduct research at the cutting edge, pushing the boundaries of knowledge, including:
 - Early-stage research often unlikely to yield direct economic benefit in time horizons required for industry (see also Study 10 under 'Innovators');
 - Breakthrough research where application is not immediately evident, but where immense value may materialise over time. Where such research involves paradigm shifts understanding the range of potential benefits may take generations;
 - Research where the primary beneficiary is government or wider society, for example in societal challenges (see also Section 2.3).
- B. Universities play a unique role in gathering, interpreting and maintaining data underpinning many discoveries and key research findings, and establishing a baseline for comparison. Our understanding of systems and

challenges often requires analysis of large longitudinal datasets. Climate change is one example of such a challenge; however, we can equally look at many other societal issues such as public health, infectious disease transmission and biological ecosystem changes. Due to their stability as institutions, experience of ethical handling of data, and trust within the community, universities are often well placed to fulfil this role.

C. Research with cultural and social value, while harder to measure, remains important to society. Such work improves our understanding of the world in which we live and enriches the lives of citizens.

A. APRU – world leaders in creation of knowledge

APRU performs well in all metrics of knowledge production as shown in Figure 15. All metrics are benchmarked such that the world average value is equal to 1. Research is:

- efficiently produced (with high publications per author),
- well cited (high citations per publication, high production of ‘star’ top cited outputs, and well cited in patents),
- highly visible (as measured by views per publication), and
- collaborative (both internationally and with industry).

All metrics are benchmarked such that the average world value is equal to 1. A value of 2, for example, in views per publication would equal twice as many views as the world average. Outputs in top percentiles (‘star publications’) refer to publications in the top 10% by citations. APRU has 1.7 times as many publications in the top 10%.

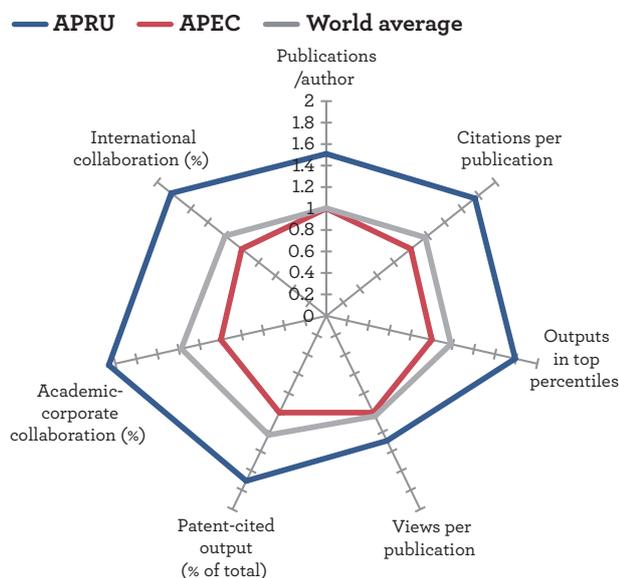


FIGURE 15: APRU substantially outperforms the world average across a variety of metrics related to academic performance, institutions are also more collaborative internationally and with local business. Data: SciVal [A]. Over 77 researchers have received Nobel Prizes to date while affiliated with an APRU institution. The number is even higher if alumni are included.

Over 77 researchers have received Nobel Prizes to date while affiliated with an APRU institution. The number is even higher if alumni are included.²⁸

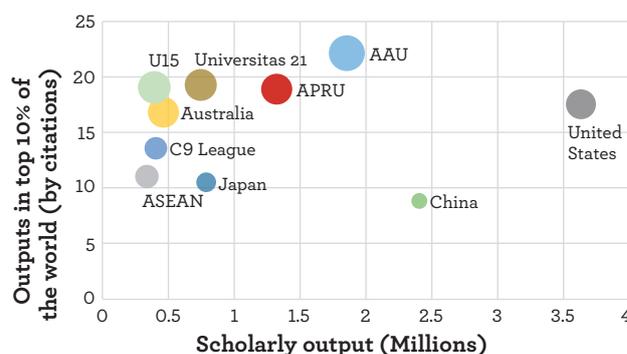


FIGURE 16: Quality versus quantity: APRU is among the highest producers of ‘star publications’ for university networks and economies while also producing a notable volume of research. Data: SciVal [A]

As a group APRU outperforms in ‘star publications’ with nearly 20% of output appearing in the top 10% of world publications; this is higher than the equivalent statistic for the USA (as shown in Figure 16). This quality proxy has been consistent through time and has been maintained even as the volume of APRU output increased over the period. The group not only contains some of the top performing institutions globally by this metric, but also some of the fastest improvers. APRU members also produce a larger share of global publications today compared to the late 1990s.²⁹

Examples of research strengths by discipline and theme across APRU and its institutions can be found in Chapter 4. APRU activities support emerging research talent; offering a platform to discuss their career aspirations and pathways within and outside academia, enhancing networking and creating opportunities for discussion. APRU’s doctoral students’ conference for example, has been running since 2000 while more recently the Early Career Researchers Network has begun to grow (now with 100 members).

B. Longitudinal data

As highlighted at the start of this chapter, universities have a unique role in gathering and analysing data, particularly large longitudinal datasets.

STUDY 4 Turning longitudinal research into real change

Growing Up in New Zealand, University of Auckland (UoA)

CONTEXT: “Growing Up in New Zealand” is UoA’s contemporary longitudinal study of child development, tracking nearly 7,000 children in the context of their families and environments from before birth to young adulthood. The study’s framework is designed to provide population-relevant evidence about the child, family and environmental influences that lead to particular developmental outcomes.

This evidence has utility, for the evaluation and development of innovative policies relating to family support and child health and development, as well as providing insight into creating more equitable outcomes across the New Zealand population.

INITIATIVE: The study is conducted by a multidisciplinary team at UoA in partnership with multiple government agencies, and spans 2008-2030. The cohort is broadly generalisable to current New Zealand births, capturing evidence about diverse family and socio-economic environments as well as across diverse ethnic groups, including Pacific, Asian and Māori.

The 'life course' model that defines the study recognises that child outcomes result from dynamic interactions between children and their environments (proximal and distal). Six key domains are incorporated into the child development framework: health and wellbeing, psychosocial and cognitive, education, family/whanāu (extended family and close community), culture and identity, societal context and neighbourhood and environment.

COLLABORATION: The multidisciplinary research team works closely with New Zealand's Social Policy Evaluation and Research Unit, and Ministries of Social Development, Health, Education, Justice, Māori Development, Pacific Island affairs and several other agencies to create and deliver evidence with utility to inform cross-sectoral policy with a view to improving wellbeing for all New Zealand children and families.

OUTCOMES: To date, six comprehensive stakeholder reports and six targeted policy briefs have been published, alongside numerous academic publications and fast-track responses to government enquiries. Fully anonymised external datasets are also made available for external researchers in academia or policy to utilise.

Other examples where APRU institutions play a key role include: climate monitoring, monitoring the Pacific Ocean and installing, monitoring and maintaining seismographic networks. The University of Oregon for example, is part of the Pacific Northwest Seismic Network (PNSN), a partnership with APRU member University of Washington and the US Geological Survey. Nearly 500 seismic sensors in Oregon and Washington provide real-time monitoring of earthquakes and volcanic activity in the states.

C. Work of cultural value & importance

Some academic areas of study have a value that is hard to quantify but may change how we view and understand the world we see today. For example, improved understanding of the past can facilitate appreciation of different cultures in the present. Such work can add meaning, depth and texture to our lives. Study 5 highlights an example of an APRU institution preserving cultural heritage and sharing this with online users around the globe.

STUDY 5 Work of cultural value and importance

Digitisation of Murals, Zhejiang University

CONTEXT: Zhejiang University has applied computer technology in archaeology and cultural heritage conservation since 1998. Remarkable high-resolution and high-fidelity digital images of precious murals in China are providing scholars with new resources.

OUTCOMES: In late 2014, during the excavation of a Northern dynasty tomb at Jiuyuangang by the Shanxi Archaeology Institute, the team digitised over 200m² of murals, capturing the layouts, contents, colours and even details of brushwork made over a thousand years ago. It is believed that at least 98% of the original has been faithfully recorded.

During May-July 2015, the team went to Western Tibet to digitise the Ming murals in the White Temple in the Mtho lding Monastery. They adapted their equipment for the weather of the plateau and the high gloss of the mural, and for the first time fully digitised murals of 320.5m² at 300 ppi.

The equipment and software for mural digitisation are now fifth generation. From 2016, Zhejiang University will digitise murals in Shaanxi, Gansu, Ningxia, Xinjiang, Tibet and Inner Mongolia.

CULTURAL KNOWLEDGE: The university is building a high-resolution image database on Chinese art and will share the digital resources with users around the world.



Mural on the north wall in the Tomb of Jiuyuangang, Xinzhou (height: 600cm)



Usnisa-sitatapatra (231X303cm)

2.3

Applying research to societal challenges

Universities create knowledge to help solve both global and local challenges. Societal impact is realised through applying this knowledge, often in collaboration with the public or private sector.

A university lead in research relating to societal challenges enables that research to take into account a range of values across all impact domains (health, environment, social, economic) and work towards benefits for society overall. This holds even when some economic benefit may materialise (e.g. in terms of reducing future costs to taxpayers or marketing solutions to other economies overseas). Universities with their global networks of experts can also develop and spread multidisciplinary solutions across borders.

This section looks at the contribution of APRU and its institutions across three challenge areas: ageing, environmental sustainability and health, while Chapter 3 takes a deeper dive into another salient issue for the Pacific Rim, disaster risk reduction.

2.3.1

Ageing

The context and varying age profiles of Pacific Rim economies have been described in Section 1. Case studies presented here highlight how APRU and its institutions are helping prepare for demographic change.

STUDY 6

Ageing & demographic change

APRU Partnering on Solutions: Population Ageing, led by University of New South Wales (UNSW)

CONTEXT: Over a period of six years APRU member universities have hosted five research symposiums on Ageing in the Asia-Pacific to discuss the impact of population ageing and to share solutions from the Pacific Rim.

COLLABORATION: In 2015 the Australian Research Council (ARC) Centre of Excellence in Population Ageing Research (CEPAR) based at UNSW implemented a new APRU Research Hub on Population Ageing to deepen Pacific Rim collaboration between junior and senior researchers. The hub was launched on 28 September 2015 at a symposium at UNSW.

OUTCOMES EXPECTED: The new hub will improve data capture on ageing in the region with greater collaboration on related research. This will assist governments and societies in preparing for demographic change and supporting those most in need.

Development of Age-friendly Social Systems, Japan, University of Tokyo

CONTEXT: Japan has the highest proportion of elderly citizens in the world. Urban and suburban communities, which enjoyed mass migration of young workers from rural areas in the last century, are now facing a wave of population ageing. For many economies and big cities of the Pacific Rim, how to develop age-friendly social systems and environments is an urgent issue. The Institute of Gerontology (IOG) is a multidisciplinary research hub of the University of Tokyo dealing with various issues regarding ageing and longevity.

APPLYING RESEARCH: IOG has an arrangement with various local governments to carry out action research for enabling an 'age-friendly society', e.g. in Kashiwa city, a satellite of Tokyo, with a population of 0.3 million.

IOG works with multiple Kashiwa governmental and other stakeholders and citizens on various social redesign activities. Projects are grouped into the following three themes:

- Development of community care systems, e.g. the network and training of health care professionals,
- Promoting social participation and prevention of frailty: suitable jobs, workplaces, meeting places, activities,
- Designing an age-friendly physical environment: barrier-free houses, public spaces, transport, city planning.

EXPECTED OUTPUTS: The role of IOG is to arrange multi-stakeholder working teams, input scientific and technical ideas, generate data and provide scientific evidence. Output will be compiled in a manual of methods or scientific theories for application elsewhere.

2.3.2

Environment and sustainability

Environmental challenges in the Asia-Pacific region are in many cases acute as a result of migration, development and resource extraction. This section looks at a few key areas and how APRU institutions are working to improve policy. Study 7 provides three different examples relating to air quality, water management and overall sustainability.

In addition, in 2016 APRU has a new platform for collaboration, the Sustainable Cities and Landscapes Research Program. This partnership between the University of Oregon, University of Washington, National Taiwan University, UNSW and Tsinghua University will conduct collaborative research around the region on how cities interact with their wider ecological and environmental landscapes. It will treat the urban environment not as a stand-alone human creation, but as a series of complex, adaptive systems tightly integrated with much wider water, raw materials, farm, food, energy, labour, product, and service flows. See Appendix 7.1.2 for a fuller description.

STUDY 7

Environmental impact – improving policy, delivering results

Addressing Air Pollution Issues in the Asia-Pacific Region: APRU Global Health Program, led by University of Southern California (USC)

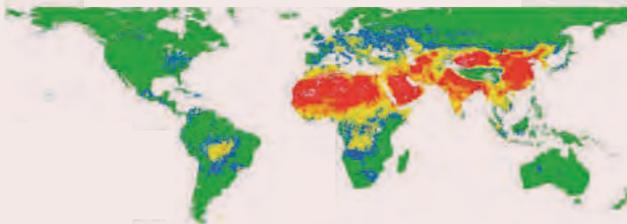
CONTEXT: Air pollution is a major public health problem contributing to morbidity and premature mortality around the world. Regulations for managing air quality in many high- and middle-income countries have led to improvements in air quality, but many rapidly developing economies of the Pacific Rim, particularly in Asia, are suffering from severe and worsening air pollution problems. The APRU Global Health Program (lead institution: USC) aims to address such global health issues.

COLLABORATION: The APRU Global Health Working Group on Air Pollution has worked to characterise air pollution regulation in the region and to compare particulate matter (PM) regulation in selected economies of the Pacific Rim, particularly PM_{2.5}.

OUTCOMES: A multidisciplinary team of experts in air pollution research from eight economies has drafted a paper entitled “Regulation of Fine Particulate Matter: Perspectives from the APRU Global Health Forum” which identifies critical issues to be considered for the management of PM_{2.5} air quality. The paper makes key policy recommendations for governments, policymakers and researchers for setting national standards in Pacific Rim economies to address this critical global health issue.

BELOW: Brauer, M et al, Ambient Air Pollution Exposure Estimation for the Global Burden of Disease 2013, Environ. Sci. Technol., 2016, 50 (1), pp 79-88.

2013 Annual Average PM_{2.5} (µg/m³)



- <10 (meets WHO Guideline)
- ≥10 (WHO Guideline)
- ≥15 (WHO Interim Target 1)
- ≥25 (WHO Interim Target 2)
- ≥35 (WHO Interim Target 3)

Improved Water Management in China and Australia, University of Melbourne (UoM)

CONTEXT: The pressure on the world’s ocean and river systems is expected to continue for at least the next few decades, while humanity tries to halt further climate change through fossil fuel divestment. In China, population impact on delicate landscapes has led to degraded rivers and food production basins. Australia faces similar threats to its major river systems due to intensive agriculture and irrigation, leading to soil and groundwater salinity problems.

COLLABORATION: The Australia-China Joint Research Centre on River Basin Management (Water Resources and Water Quality) has been set up, based at both the Chinese Institute of Water Resources and Hydropower Research and UoM.

TECHNOLOGY INNOVATION: Remote sensing of soil moisture (using microwave satellite) for groundwater mapping is well advanced, providing data on the impact of recently built dams in the Mekong River Basin, as well as activities in Australia’s Ovens Catchment area.

POLICY DEVELOPMENT: UoM is leading the delivery of the Australian Blueprint for Regional Water Productivity. An extensive consultation process is employed to understand how to achieve greatest value from limited regional water resources, drawing input from farmers, policymakers, researchers, agencies, and many other local and national stakeholders. This innovative and collaborative process will lead to policies supporting more sustainable development and more resilient regional communities.

Sustainable LA Grand Challenge: Thriving in a Hotter Los Angeles, University of California, Los Angeles (UCLA)

CONTEXT: UCLA launched its ‘Sustainable LA Grand Challenge – Thriving in a Hotter Los Angeles’ in 2013. Goals are 100% renewable energy, 100% locally sourced water, and enhanced ecosystem health by 2050. This unites university resources in tackling some of society’s pressing issues, aiming to turn Los Angeles into a global model for sustainable living.

COLLABORATION: ‘Sustainable LA GC’ brings together more than 150 UCLA faculty members, researchers and scholars from more than 40 UCLA departments, who in turn are part of a network of the world’s top experts in sustainability.

GOALS: In 2020, the plan will detail the technologies, policies and strategies needed to make LA County sustainable by achieving the following three goals by 2050.

1. Power 100% of energy and transportation needs with renewable energy
2. Obtain 100% of water supply from sources within LA County
3. Enhance ecosystem health together with human health and wellbeing: increase native biodiversity, prevent extinction of native species, integrate development and nature to promote human health, and ensure every resident has access to a green space or natural area within ¼ mile.

INNOVATION: Such breakthrough goals will require technological and policy innovations, e.g.:

- Clean technology breakthroughs
- Economic opportunities for LA residents that dramatically reduce air pollution and increase quality of life
- Planning and engineering to use surfaces such as awnings, window blinds, and even house paint to generate electricity
- Intelligent regulation of electricity use of all devices, appliances, and electric vehicles
- Redesigned transportation infrastructure to support a mass-transit system and shared, self-driving vehicles
- Live-work neighbourhoods to be more energy efficient, reduce car dependence, and make LA County pleasant for all.

2.3.3

Health

APRU institutions are particularly strong in various health areas, collectively displaying specialisation in terms of underlying disciplines such as biochemistry, genetics, molecular biology, neuroscience, immunology and microbiology. At the sub-discipline level strengths in biomedical engineering, epidemiology and cancer research are evident (see Chapter 4 for further information).

The APRU Global Health Program referenced in the previous section (under Study 2) aims to leverage the global health education and research of Asia-Pacific universities to address global health issues through interaction with public policy and media. Since its launch in 2007-2008 it has been an active and successful collaboration. Case studies on this program are included in other sections as they encompass a range of dimensions (leadership, education, collaboration with policymakers) as well as covering multidisciplinary issues such as environmental health. Further information can be found at <http://apruglobalhealth.org>.

STUDY 8 Health technology

Leading the Development of the Bionic Eye, University of New South Wales (UNSW), Australia

CONTEXT: Nearly 200 million people across the globe have a degenerative eye condition such as macular degeneration or retinitis pigmentosa, and this is expected to almost double by 2030 with population ageing.

Retinitis pigmentosa is the leading cause of blindness in younger people. The degenerative condition affects 2 million people worldwide, and strikes in the prime of life often when a person is in their 30s. There are few ways to predict its onset, progression or severity, and it can lead to complete blindness within a decade. A new fully implantable device known as the bionic eye has the potential to transform the lives of those living with the condition.

RESEARCH: in 1987, UNSW biomedical researchers had a vision to build a bionic eye. By 2009, progress was such that Bionic Vision Australia (BVA) attracted AU\$42m of Special Research Initiative funding from the Australian Research Council, that includes APRU partner University of Melbourne and a number of international researchers.

By 2012 the BVA team tested their first partially implanted prototype in three patients with retinitis pigmentosa. The 24 electrode array with external electronics allowed users to see spots of light, called phosphenes, and with special cameras and algorithms they were able to get a sense of distance.

OUTCOMES: Pre-clinical prototype work culminated in 2015 with the successful demonstration of the fully implantable UNSW Phoenix 99 bionic eye system. This new device represents many world firsts in neural stimulation technologies and should allow for vision that is several times better than previously achieved.

From Discovery to Application: Advanced Stem Cell Therapies and Medicines, Kyoto University

CONTEXT: Induced pluripotent stem cells (iPSCs) are an invention of a research team led by Dr Shinya Yamanaka, who reported them in 2006 and who has won numerous awards culminating in the Nobel Prize in 2012. They describe cells that have been reprogrammed so that they can in theory be multiplied and converted to any cell type of the human body, presenting an opportunity for new medicines and therapies, especially for intractable diseases.

INITIATIVE: The Centre for iPS Cell Research and Application (CiRA) was set up by Kyoto University in 2010

under the directorship of Dr Yamanaka and has doubled in infrastructure and headcount over six years. The institution's status and importance is indicated by private donations of over 500 million yen annually since the Nobel Prize.

OUTCOMES: The first iPSC-based surgery was performed on humans in 2014, when a patient suffering from macular disease had her skin cells reprogrammed to retinal cells via iPSCs and transplanted back. Her vision, which was rapidly diminishing prior to the operation, has shown signs of stability.

Similar treatments for Parkinson's disease and thrombocytopenia are expected within a few years. Many other diseases are being targeted and extensive partnerships have been formed with pharmaceutical companies.

STUDY 9

Infectious diseases – applying research to reduce the threat and spread of disease

Battling HIV Spread with Needles, University of Malaya

CONTEXT: University of Malaya has positioned itself to transform lives and societies through research that brings benefits to humanity. The Centre of Excellence for Research in AIDS (CERiA) has strongly advocated the adoption of a pragmatic, effective and evidence-based approach to HIV prevention among people who inject drugs.

OUTCOMES: Research evidence and a drive for harm reduction enabled CERiA to counter opposition and in 2005 successfully introduce programs of methadone substitution therapy and needle exchange. This is estimated to have prevented about 39% of new infections and saved RM47 million in healthcare costs over the first eight years. The work led to Malaysia's adoption of a public health approach towards illicit drug use, displacing a purely criminal justice approach.

The team made a major contribution by publishing an enquiry by Islamic scholars which concluded that harm reduction is consistent with Islamic principles and thought, and provided a practical solution to a problem that could result in far greater damage to society if left unaddressed.

ASIA-PACIFIC INFLUENCE: Malaysia has been seen as a role model for the countries grappling with HIV epidemics driven by drug injection. Countries such as Vietnam, Myanmar, and Bangladesh have since begun to adopt a harm reduction approach.

Dengue Fever Prevention: Containing Aedes Egypti, National Taiwan University (NTU)

CONTEXT: Dengue fever is an acute contagious disease transmitted through mosquito bites. It is prevalent in southern Taiwan where the serious outbreak in Tainan City in 2015 resulted in over 17,000 infections within months. The spreading of misconceptions about dengue fever prevention delayed an effective response.

OUTCOMES: NTU's College of Public Health (NTU-CPH) began educating the public on prevention: regularly cleaning homes, emptying stagnant water, biological prevention, and in the event of an epidemic, strengthening patient diagnosis and treatment and control of breeding sources.

NTU-CPH worked closely with the local city government's department of health to eliminate breeding sources. They discovered that the prevalence in southern Taiwan was related to the existence of Aedes Egypti, the vector mosquito.

NTU-CPH identified freshwater cyclops as an agent for suppressing Aedes Egypti larvae, which proved to have outstanding results. The college is commissioned to assist with education and the identification of local cyclops for dengue prevention.

ASIA-PACIFIC IMPLICATIONS: Aedes Egypti is one of the commonest mosquitoes in the tropics; these studies and practices have clear applicability across the region.



Responding to Emerging Infectious Disease Threats, University of Hong Kong (HKU)

CONTEXT: Emerging infectious diseases (EID) occur unpredictably and may have significant impact on human health and societies. Because most EIDs derive from animal sources there is a need to address that interface, and swift, effective response requires multidisciplinary teams that engage research, clinical service, public health and policy experts.

GLOBAL RESEARCH LEADERSHIP AND COLLABORATION: HKU is making worldwide impact on influenza control and receives global recognition in this area, e.g. providing laboratory analysis, identification of strains, providing candidate vaccines, training and advice on methods of containment for SARS, avian influenza, and MERS.

SARS (2003): The team at HKU was the first to identify the causative agent of the unusual respiratory disease emerging in adjacent Guangdong to be a novel coronavirus, and the first to develop and deploy diagnostic tests. The team shared critical knowledge with the World Health Organisation (WHO) and made a significant contribution to containing the global epidemic. It also identified live game animal markets as the interface where the species-jump occurred, and went on to identify the natural reservoir of this virus in bats, contributing to the recognition of bats as the source of many human and animal coronaviruses.

ZOONOTIC AND PANDEMIC INFLUENZA (1997 TO DATE): Following the emergence of avian influenza H5N1 in Hong Kong in 1997, the HKU team was able to give early warning of its re-emergence in 2004 and provided evidence-based interventions within the poultry marketing system that significantly reduced human health risk. As a result, there have been no locally-acquired cases of H5N1 (or the more recent H7N9) virus in Hong Kong since 1997, in spite of the many hundreds of cases in the wider region.

In early 2004 and 2005, the team provided local and regional (e.g. Vietnam, Indonesia, Thailand) training and expertise to aid responses to H5N1 outbreaks. As the WHO H5 reference laboratory it has provided WHO with significant information on the evolution of this virus to help the selection of vaccine strains, many of which were provided by the HKU research team.

MERS (2012 TO DATE): The team has made seminal contributions to defining dromedary camels as the animal source of zoonotic MERS. Through collaborative studies with veterinary and environmental authorities in Saudi Arabia, Egypt, and other African and Asian countries, it defined the geographic distribution of the virus. The team developed and validated a novel serological test for detecting the MERS-CoV antibody and has provided training for laboratory workers in the Arabian Peninsula on the diagnostics of MERS.

2.4 Innovators and industry collaborators

Universities are a hotbed of new ideas and knowledge *creation*, but staff and students may also *innovate*, applying existing knowledge to new areas, in new ways, or may assist others to find new solutions to problems or create added value. In this section we focus on the universities' role in this process of innovation and in applying knowledge to the business sector.

A. Intellectual property & commercialisation:

Increasingly universities are encouraged to protect and extract value from the intellectual property they create, both by politicians but also often internally to balance the books in the face of shrinking real budgets, increasing student numbers and increasing demand for other university activities. This aspect of the role covers developing and protecting intellectual property generated during knowledge creation that may be developed further within the university setting, licenced to others, or acquired by private parties.

B. Collaborating & assisting businesses with problem solving:

Universities can help businesses develop new products, processes and solutions to problems. This work may occur through collaboration or the provision of contract services by providing a 'neutral' platform for collaboration between different local stakeholders, connecting small businesses to knowledge, or transferring knowledge from overseas to local industry.

C. Developing the next generation of innovators:

Some universities have placed significant effort into building a culture of entrepreneurship, for example, through supporting young entrepreneurial students and their development through programs, competitions and other activities.

Innovating for the public sector and for service providers is highlighted under Section 2.3: Applying research to societal challenges.

Not all institutions cover the three dimensions highlighted equally. The balance between collaboration, contracting of services and direct commercialisation of intellectual property depends in part on the needs and receptive capacity of the surrounding environment. There are APRU institutions with strengths in each of these areas.

A. Intellectual property commercialisation

Patents are not a perfect indicator of innovation, as not all inventions are patented and the use varies by sector; nevertheless, they are a commonly used proxy. APRU institutions are strong performers in patent applications under the Patent Cooperation Treaty (PCT), with 14 universities in the top 50 in 2014 according to the World Intellectual Property Organisation (WIPO) (Figure 17).

The institutions of the University of California (UC) for example, have been successfully commercialising intellectual property over the past 35 years through various mechanisms, including licences and start-ups.

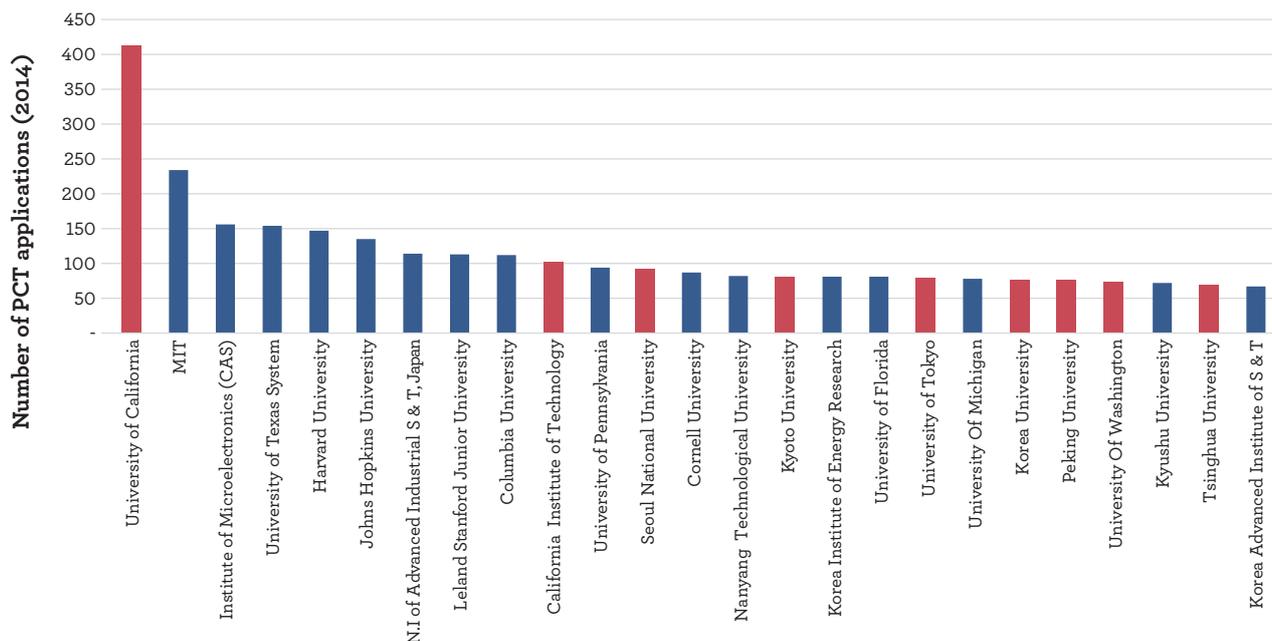


FIGURE 17: Patent applications by the top academic players according to the WIPO, APRU institutions marked in red. Data: WIPO [1]

The number of new UC companies has been rising each year from around 25 in 2000 to 86 in 2014. Today there are close to 20,000 employees in active UC start-ups, with combined annual revenues exceeding US\$ 14 billion. Over 170 start-ups have a product on the market. Medical therapeutic start-ups dominate both the revenue and employment data.³⁰

The following case study looks at how world-leading research is being applied in industry.

STUDY 10 From world-leading research to industrial application

Leading the World in Renewable Energy Research, University of New South Wales (UNSW)

CONTEXT: Over 2 billion people on the planet have no access to power and the environmental impact of fossil fuels is well documented. Out of a commitment to finding sustainable ways of generating energy for all, UNSW researchers have developed the most efficient photovoltaic technology in the world.

Solar technology will be central to meeting the UN Sustainable Development Goal of ‘ensuring access to affordable, reliable, sustainable and modern energy for all’.

CONTINUED INNOVATION: UNSW has led the world in silicon cell efficiency research since 1983, paving the way for the mass production of solar panels and offering a viable alternative to fossil fuels. UNSW holds the world record for solar panel efficiency, currently at 40%; the latest prototype uses a custom optical bandpass filter to capture sunlight that is normally wasted by commercial solar cells. The push is to make solar the cheapest and most accessible energy, transforming the world’s power systems.

COMMERCIALISATION: Intellectual property developed by the Photovoltaics Centre of Excellence at UNSW is being used by the world’s largest silicon photovoltaic manufacturing company. Several of the world’s largest solar companies were established by or have senior managers who are alumni of the Centre of Excellence.

B. Collaborating and assisting with problem solving

The ability for institutions to collaborate with industry depends on the receptive capacity of the surrounding business environment and its needs. Institutions may also offer contract services to companies wishing to outsource certain activities, particularly where insufficient capacity of skills exists in house. Businesses may also benefit from research produced by institutions without collaboration or contractual arrangements through review of published data, recruitment of staff with embedded knowledge and other indirect routes.

Contract services

Examples of services offered by institutions to companies include:

- Independent testing of products/materials
- Academic consultancy
- R&D capacity through provision of PhD students (or similar)
- Access to facilities for R&D

Collaboration: Collectively, APRU has a high rate of academic-corporate collaboration on publications compared to the global average.ⁱⁱ The collaboration rate in the group seems to correlate with a quality proxy of research (i.e. the rate of production of 'star' output as measured by citations). One sub-group (the Japanese and Korean APRU institutions) shown in green (below) has a higher rate of academic-corporate collaboration than expected by citations alone.

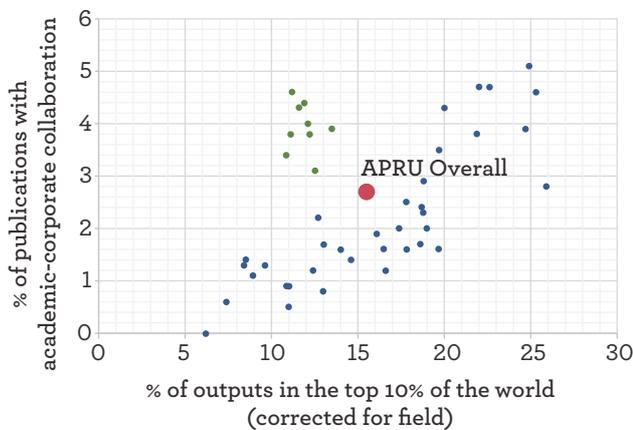


FIGURE 18: Collaboration with industry correlates with rate of production of 'star' research publications, and is high for APRU overall relative to the world average. Data: SciVal [A]

C. Developing the next generation of innovators

Statistics on university commercialisation of IP receive much press, however, a less well recognised role, and one with arguably greater impact, is the creation of a culture of entrepreneurship in the student body. Alumni bring this culture and experience to their future careers whether this be through starting their own businesses or through their employment elsewhere.

STUDY 11 Student Innovation

Improving Bone Surgery in the Developing World, University of British Columbia (UBC)

CONTEXT: The 'Engineers in Scrubs' graduate program at UBC pairs engineering students with doctors to find solutions for hospitals. One of the program's teams, Arbutus Medical, developed a sterilisable drill cover that allows low-cost electric drills to be used in place of US\$30,000 orthopaedic drills, or the hand drills more commonly used in developing countries for bone surgery. The drill covers ensure sterility in the operating room and result in faster surgery times per patient. After developing the drill cover, Arbutus Medical aimed to enter the international market, with a goal to become the leading provider of surgical technology for the developing world, but the team did not have a strategy.

INCUBATION: Arbutus Medical joined the entrepreneurship@UBC Accelerator in January 2014 to define their target customers and assess how to enter the market. Testing their hypotheses over the five-week program by talking to approximately 50 customers helped identify two main market segments – hospitals in emerging markets and disaster relief organisations globally. The team also worked with mentors to develop investor relationships to help scale their business, concentrating their investor pitch on a for-profit model while still maintaining their focus on social impact.

RESULTS: The Arbutus Medical team have brought their business to the next stage of development with prototypes in seven countries and have launched pilots with major global aid partners such as Save the Children. The team have also supplied drill covers to disaster relief organisations in Syria, Ukraine and Haiti, and a successful crowdfunding campaign enabled them to provide drill covers for hospitals in Nepal after the large earthquake in April 2015.



ⁱⁱ This proxy is likely an underestimate of collaboration in practice as it relies on publication of the data and the company being included in the authors.

2.5

Connectors and cultural bridges for the Asia-Pacific region

A. Cultural bridges – As highlighted in Chapter 1, the Asia-Pacific is a culturally diverse region. Universities have a role to play in fostering understanding between different cultures. This occurs through a variety of routes, through international collaborative programs, educational program offerings and activities but also indirectly through exchange of faculty and students across borders.

B. Knowledge conduits – Universities act as a conduit, bringing global knowledge to a local market. This may be through programs to address specific audiences or challenges, through collaboration or more informal advice routes.

C. Connectors – Due to their credibility and degree of independence, academic institutions can connect different stakeholders or parts of the community to enable discussion and collaboration. In some cases they may even manage and provide access to virtual or physical infrastructure where stakeholders can interact.

APRU institutions overall display high levels of international and national collaboration in their research (Figure 19).

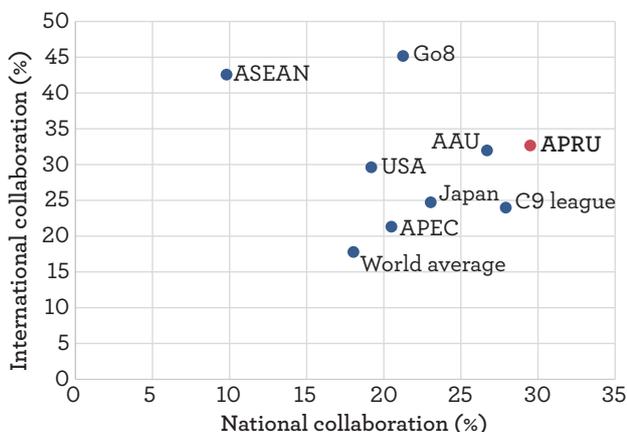


FIGURE 19: APRU national and international collaboration rates are high compared with the world average, APEC, selected economies and selected APRU-equivalent organisations. Data: SciVal [A]

A: Cultural bridges – understanding, and student exchange

Asia-Pacific regional educational hubs

APRU institutions have an excellent reputation internationally for education, with several of the universities acting as regional educational hubs. Institutions where 20% or more of the student body are international students include NUS in Singapore, University of British Columbia (Canada) and the Australian universities (Melbourne, ACT, UNSW,

Sydney).³¹ University of Auckland is not far behind and while the figures are lower, USC, Stanford and Caltech have very high levels of international students for US universities.

International educational experience benefits both the students and the host economy. It also establishes cross-cultural ties which persist through alumni who may remain or return to their home country.

“Australia’s international education activities generate over \$15 billion of export income annually and this revenue supports more than 100,000 jobs. Australian staff, researchers and students gain many benefits from the contributions made by international students”
Australia – Educating Globally report, 2013.

STUDY 12

Internationalisation of education

International Summer Campus Program for International Students, Korea University (KU)

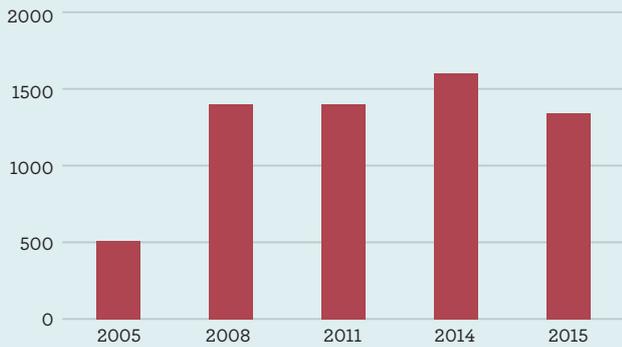
CONTEXT: KU faced the situation where the outflow of students studying overseas was not matched by a similar inflow. KU launched the first and most successful summer campus program of its kind in Asia in 2003. The result has been a large number of students visiting KU and Korea for the summer, and having a positive cultural and academic experience in Asia.

CULTURAL EXCHANGE: By developing a four-week track and six-week track credit-granting program during the summer, with the same teaching hours as a regular 16-week semester, KU created an attractive summer program allowing students with little exposure to Asian culture a viable option to explore one of the most vibrant and fascinating cities in Asia. Typically, students from 40 different countries participate annually.

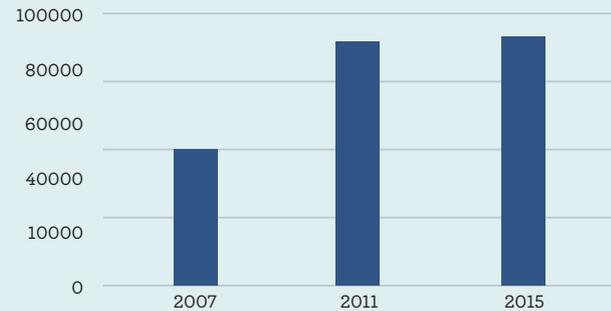
Staffing the program with professors from top universities around the world (e.g. Cambridge, Oxford, Stanford, Cornell etc.) helped to enhance the quality of the courses offered (over 100 delivered in English), and assists in the promotion of academic cooperation and research collaboration between faculties.

RESULTS: Attendance statistics for KU ISC Program have grown substantially since its inception and the model has been copied by other Korean and Asian higher education institutions. From a low base, Korea has seen an explosive growth of incoming international students.

Attendance at KU ISC



International Students in Korea



B: Knowledge conduits

Activities to bring knowledge and training to local service providers and businesses go well beyond collaboration on research publications, as evidenced by examples in Study 13 presented below.

STUDY 13 Cultural bridges & knowledge: empowering local service providers

Tobacco Control Advocacy and Leadership Training in China, APRU Global Health Program, lead by: University of Southern California (USC) and Fudan University

CONTEXT: The prevalence of smoking is high and rising in China, with significant health consequences. California has much knowledge to share after decades of lobbying and initiatives to reverse the trend in smoking.

PARTNERSHIP INITIATIVE AND KNOWLEDGE

TRANSFER: Developed through a partnership between USC and Fudan University in Shanghai, a new program trained 30 leaders from universities around China in November 2015. The trainees learned how to partner with local government agencies and community-based organisations to obtain support and endorsement for their anti-smoking efforts. They

learned how to use media to advocate tobacco control such as prohibiting sale to students and minors and advertisement of tobacco products in places frequented by young people. The training successfully provided the leaders with critical skills to combat rising smoking rates and established a new network of tobacco control leaders in China.

USC facilitated by identifying and developing the proposal to obtain funding from the Bloomberg Foundation for the project.

Providing Working English Skills to Local Stakeholders, Chulalongkorn University (CU)

CONTEXT: Sichang Island, close to Thailand's Eastern Seaboard, has seen significant economic development as a deep sea port. It is also a popular tourist attraction for local and regional visitors. Local people need to adjust to the changing environment, but have minimal knowledge and skills in English. CU has built a practical English course for local service providers.

DELIVERY: The project was delivered in three phases as follows:

PREPARATION: The authentic use of English in a variety of situations was captured by facilitating conversations between foreign tourists and many local service providers. Actors and a production team adapted them into video clips, shot with the help of local people at a number of famous tourist spots. The clips are captioned and provide translations of useful phrases, with a teacher's guide to usage. They were distributed on two CDs.

EXPOSURE AND PRACTICE STAGE: Service providers received a set of CDs for self-study. A booklet consisting of karaoke-type letters instructs on pronunciation. In addition, CU offered opportunities for further practice and reinforcement in real situations during a short four-hour session for each group of service providers. The participants practised using expressions in various situations – how to greet, how to apologize, how to give advice, how to give directions, etc. Each participant was evaluated for accuracy and fluency, and the greatest improvers in each profession group received a reward. The participants developed more self-confidence and pride in themselves.

EVALUATION STAGE: In a recent survey and focus group interview, the people of Sichang Island great satisfaction with the program and expressed a strong desire to participate in further communicative English activities.

C. Connectors

As a result of thought leadership, international connections and the ability to provide a relatively neutral forum for debate, universities are able to provide a forum for international dialogue. Recently APRU has been active in supporting such dialogue on the topic of the digital economy.

STUDY 14 Cooperation between stakeholders across the Asia-Pacific region

Our Evolving Digital Economy, Keio University and APRU

Governing the internet economy – cooperation with policymakers

CONTEXT: The APRU initiative “Governing the Internet Economy” was launched in 2014 at APRU’s 18th Annual President’s Meeting, reflecting a commitment to help shape the regional conversation on the future of the internet, based on sound research and analysis. Universities have a unique role in training and equipping the next generation of Asia-Pacific leadership in the internet policy field.

INITIATIVE: Supported by a three-year grant from the Sasakawa Peace Fund, Keio University convened a six-day APRU Internet Economy Summer Seminar in August 2015. The Seminar targeted mid-level government officials from around the region responsible for internet regulation. It was the first event of its kind in the Asia-Pacific region and featured a 25-member APRU faculty from Japan, the US, Korea, China, Hong Kong, Malaysia, and Indonesia.

Support from governments in the region was very strong, with 15 government officials joining from Japan, the US, Korea, the Philippines, Malaysia, Indonesia, Australia and Vietnam. Major Japanese corporations including NTT, Fujitsu, Rakuten, Yahoo Japan and Sony also registered their support for the Seminar, sending ten of their top young executives.

OUTCOMES: The Seminar Report and Reading List demonstrate the quality of the discussion. The findings were reported at the Pacific Economic Cooperation Council (PECC) meeting in September 2015 and will be incorporated into the agenda for the nearly formed APEC Ad Hoc Steering Group on the Internet Economy.

Identifying priorities and challenges in the digital economy – forum for debate with industry

CONTEXT: In March 2015, Keio University hosted the first APRU Internet Business Offsite, bringing together scholars representing 17 universities with senior business executives from major internet-related businesses in Japan, the US, and Korea. Participants exchanged views on their research agendas and business models regarding the next ten years of the internet in the region.

INITIATIVE: The program was a frank, off-the-record exchange designed to highlight priorities for business and upcoming policy challenges in the digital economy. The Offsite was funded by contributions from participating corporations and promises to become an annual event.

Providing a Platform for Cooperation with other Asia-Pacific Groups, Far Eastern Federal University (FEFU)

CONTEXT: FEFU is a Russian higher education institution that has a leading role in developing international cooperation with the Pacific Rim. In 2015 the leadership of the APEC Human Resources Development Working Group (HRDWG) moved to Russia.

APEC HRDWG expanded its membership to include APRU for three years with guest status. The link to APEC provides an opportunity to share best practices on human resource development, a topic at the top of APRU’s agenda.

INITIATIVES: In these last few years, FEFU, as federal university and educational focal point of the Russian Far East, has successfully proven itself as a convenient venue for scientific communication between Russian and international experts from the Asia-Pacific region. A series of APEC Conferences on Cooperation in Higher Education have been held at FEFU in Vladivostok (2012-2015). These focused on integration of educational systems in the Asia-Pacific region, creation of mechanisms for strengthening education and mobility cooperation, cross-educational interaction, and exchange of knowledge and information. The conferences have become a platform for approval and replication of best practices and successful cooperation in the field of human capital development in the region.

OUTCOMES: During 2015, a preliminary study of the development of human capital in the Asia-Pacific region was conducted that helped inform promising policy approaches of human development in the Asia-Pacific region. New policy approaches for the development of human potential in APEC and its promotion in the Asia-Pacific region have been defined.

2.6

Agents of change

Universities offer forums for debate and public dialogue. With an established culture of academic freedom, they have long played a traditional role as the critical conscience for society. Universities also move beyond this to test and trial new ideas on campus, lead by example, and gather data and experience on what works well. Finally, once data and research supports a best practice approach, institutions may be instrumental in supporting change and wider roll-out. Thus the role includes the following dimensions:

- A. Critical conscience for society
- B. Testing & trialling new ideas
- C. Supporting reform towards best practice (see also, for example, Study 2 on mental health reform)

Examples can be found in the studies below.

Other case studies (see Section 2.3: Applying research to societal challenges) also contain examples of advocacy for reforming best practice, particularly in relation to infectious diseases.

STUDY 15

Universities acting as critic and conscience of society

Addressing Misrepresentation in the Entertainment World, University of California, Los Angeles (UCLA)

CONTEXT: Hollywood images portrayed on screen reflect back upon society and give us a sense of who we are. This influences not just how we feel about ourselves and those around us, but the choices we make and how we interact in an increasingly diverse and mediated society. At present, Hollywood does not accurately reflect modern society. When marginalised groups are absent or when media images are used primarily in stereotype, inequality is normalised and is more likely to be reinforced over time through our prejudices and practices. UCLA has actively sought to correct this misrepresentation and to promote change and diversity; and, because of its unique proximity, it is provided with unrivalled access to Hollywood's leaders and creative talent.

INITIATIVE: The annual Hollywood Diversity Report explores the relationships between diversity and the bottom line in the Hollywood entertainment industry. The Diversity Report found that minorities and women posted small gains in Hollywood employment arenas but remain under-represented on nearly every front. However, it also found that more diverse TV shows are more popular and movies with diverse casts did best at the worldwide box office.

This work is part of a wider Hollywood Advancement Project which seeks to generate comprehensive research on the inclusion of diverse groups in film and TV, identify and disseminate best

practice, and consider broader implications for society. With the information generated in the Advancement Project the UCLA staff have met with many in the industry in an effort to better understand how day to day business practices may erect barriers to or provide opportunities for advancement in Hollywood.

OUTCOMES: The reports have received repeated references from multiple media sources, for example when it was revealed recently that, for the second year in a row, no non-white actors were among the 20 acting nominees for the 2016 Academy Awards. The issue has been brought to the fore in the public conscience.

STUDY 16

Trialling new ideas, preparing for change

Entrepreneurship and Employment Academy for North Koreans, Korea University (KU)

CONTEXT: North Koreans defecting to the South often experience an extremely difficult period of cultural adaptation and assimilation. In addition, they are often at a disadvantage due to a lack of financial resources, quality educational opportunities and a general knowledge of modern South Korean social, political and economic life.

TRIAL PROGRAM: The Korea University Social Service Organisation (KUSSO) launched the "KU Entrepreneurship and Employment Academy for North Korean Defectors" in June 2015, to improve the quality of life of North Koreans in South Korea by enhancing their individual abilities and economic competencies. Funding was provided by a generous grant of US\$240,000 from the JP Morgan Foundation.

Candidates come from among the 27,500 North Koreans currently living in South Korea. Seventy were selected from 83 applicants. Most are 20-30 years old and have already completed the six-month government re-education program.

The seven-month program is administered in three phases, including lectures, workshops with one-to-one mentoring from business leaders, and making practical plans to start a business. The best and brightest from each graduating class receive seed-money to finance their own business ventures.

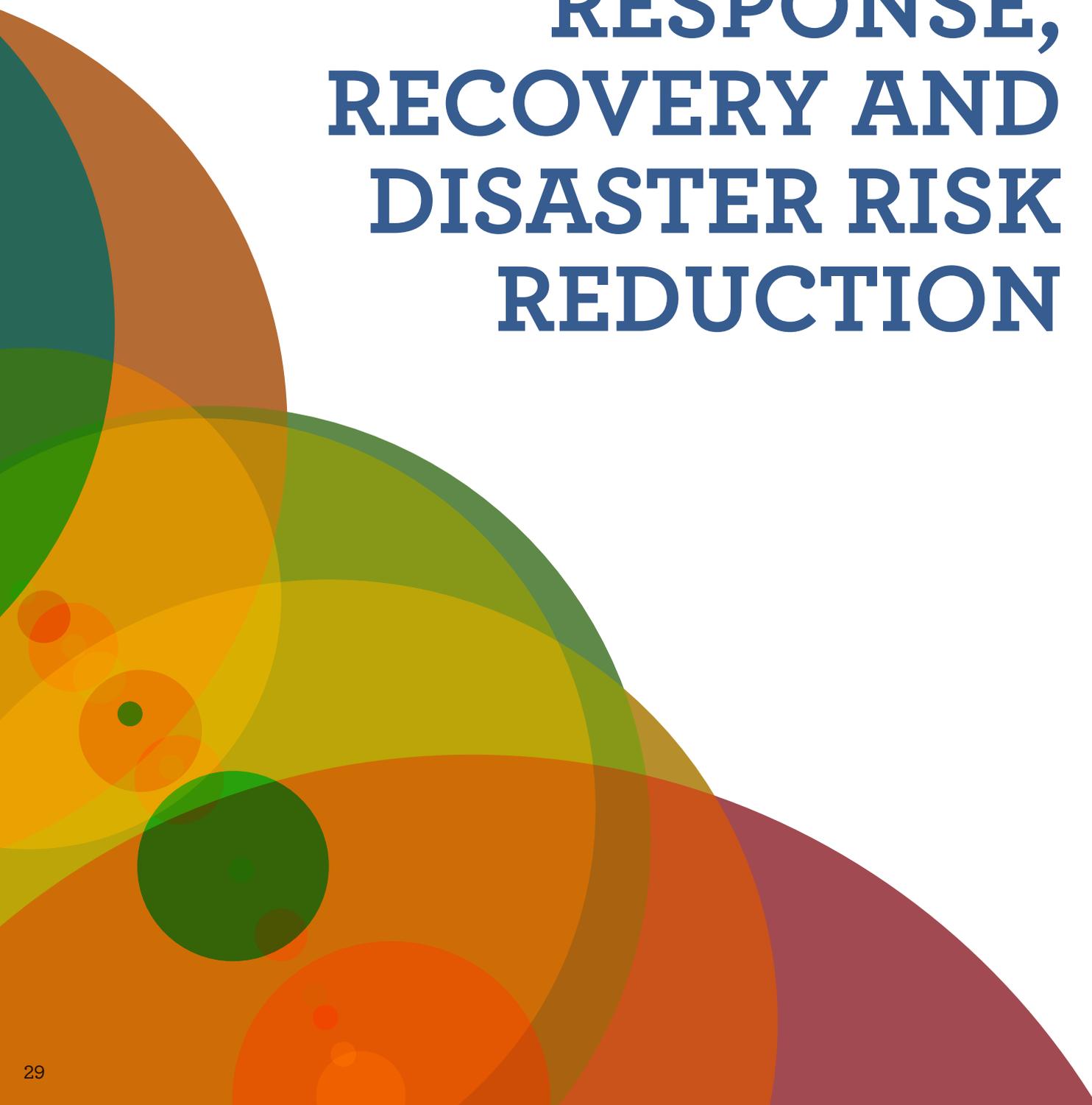
OUTCOMES: On completion students have learned the social, political and economic differences between South and North Korea, identified a business sector of professional and personal interest and put together a business plan, while taking steps to begin its implementation.

The aim is that graduates of this program will (i) develop into successful entrepreneurs in South Korea in the short term and (ii) play a leading role in the restoration of the North in the future.

The first two cohorts of program participants graduated in August and November 2015.

3.

**THE
CONTRIBUTION
OF APRU TO
RESPONSE,
RECOVERY AND
DISASTER RISK
REDUCTION**



APRU institutions excel academically in the area of natural hazard research and disaster risk reduction, offering world-class research expertise in this topic of importance to the Pacific Rim as highlighted in this chapter under Section 3.2. The impact of APRU and APRU institutions also extends beyond research and is explored here through case studies in Section 3.3. Activities span the roles described in Chapter 2 including education, knowledge creation, application to societal challenges and connection. They also work across the disaster management cycle improving:

- disaster mitigation through structural and non-structural measures,
- disaster preparedness through identification, education and risk reduction,
- disaster response (both through improved coordination, communication and governance and the application of engineering solutions),
- and finally helping communities recover from disaster and ‘build back better’.

APRU Multi-Hazards program^{III}

APRU’s Multi-Hazards (MH) program builds upon the strengths and collective capacities of APRU institutions in economies spanning the Pacific ‘Ring of Fire’ aiming to build safer and more disaster resilient societies through education, research and partnerships. Established in April 2013 on the second anniversary of the 2011 East Japan earthquake, it is led from the International Research Institute of Disaster Science (IRIDeS) at Tohoku University.

The MH Program has also been engaged in international policymaking processes to improve disaster risk reduction (DRR) and has advocated for the importance of science and technology in DRR as well as involvement of academia and scientific institutions. Recently the United Nations ‘Sendai Framework for Disaster Risk Reduction’ (2015-2030) highlighted the need to:

- Promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery and rehabilitation, in formal and non-formal education, as well as in civic education at all levels, and in professional education and training,
- Strengthen technical and scientific capacity to capitalise on and consolidate existing knowledge and to develop and apply methodologies and models to assess disaster risks, vulnerabilities and exposure to all hazards,
- Ensure the use of traditional, indigenous and local knowledge and practices, as appropriate, to complement scientific knowledge in disaster risk assessment,
- Promote and improve dialogue and cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science policy interface for effective decision-making in disaster risk management.

3.1 Context – the challenge

Globally, between 2000 and 2012, disasters have cost over 1.2 million lives, affected over 2.9 billion people and caused over 1.7 trillion US dollars of economic damage.³² The risk of economic impact and loss of life vary from country to country. While 89% of storm-related deaths, for example, occurred in lower-middle-income countries (LMIC) (for 26% of events), the bulk of economic losses occurred in higher-income countries (93%). Geophysical events are responsible for around 29% of global economic damage as shown in Figure 20.

Number of disasters globally, 1995-2015 by type

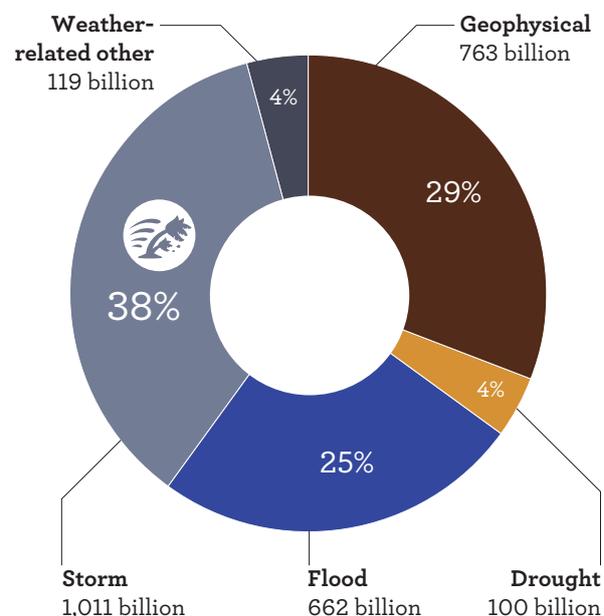
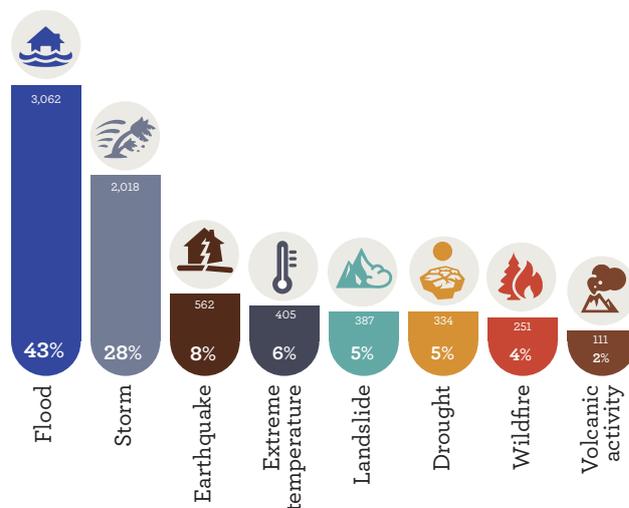


FIGURE 20: Floods and storms dominate the numbers of disasters worldwide, however earthquakes cause a disproportionate amount of global damage. Top: Number of disasters globally, 1995-2015 by type. [W]. Bottom: recorded economic damage by disaster type. Source: UNISDR

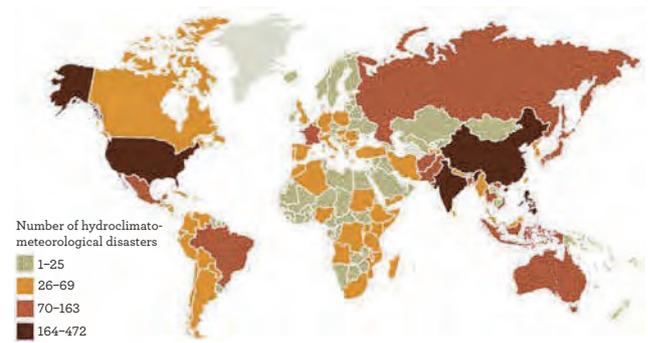
III Further information on the Multi-Hazards Program can be found at: <http://aprumh.irides.tohoku.ac.jp/app-def/S-102/apru/about/multi-hazards-program>

Economies situated around the Pacific Rim on the ‘Ring of Fire’ dominate geophysical event statistics (Figure 21) and dominate both in terms of exposed population and infrastructure. The Asia-Pacific region is also particularly vulnerable to storms with Asia representing around 21% of the global total for events and 80% of storm mortality.³³

Impact of disasters on APRU economies: 1990-2015

The Asia-Pacific region contains some of the world’s economies most exposed to disasters. The Philippines and Japan were recently described by the UN Environment Program as two of the most exposed economies worldwide, only topped by two Pacific Island states. Small island states

Number of weather-related disasters reported per country, 1995-2015. Source: UNISDR [W]



Map of earthquakes, tsunamis and volcanic events. Source: historical events from www.preventionweb.net (UNISDR) [W]

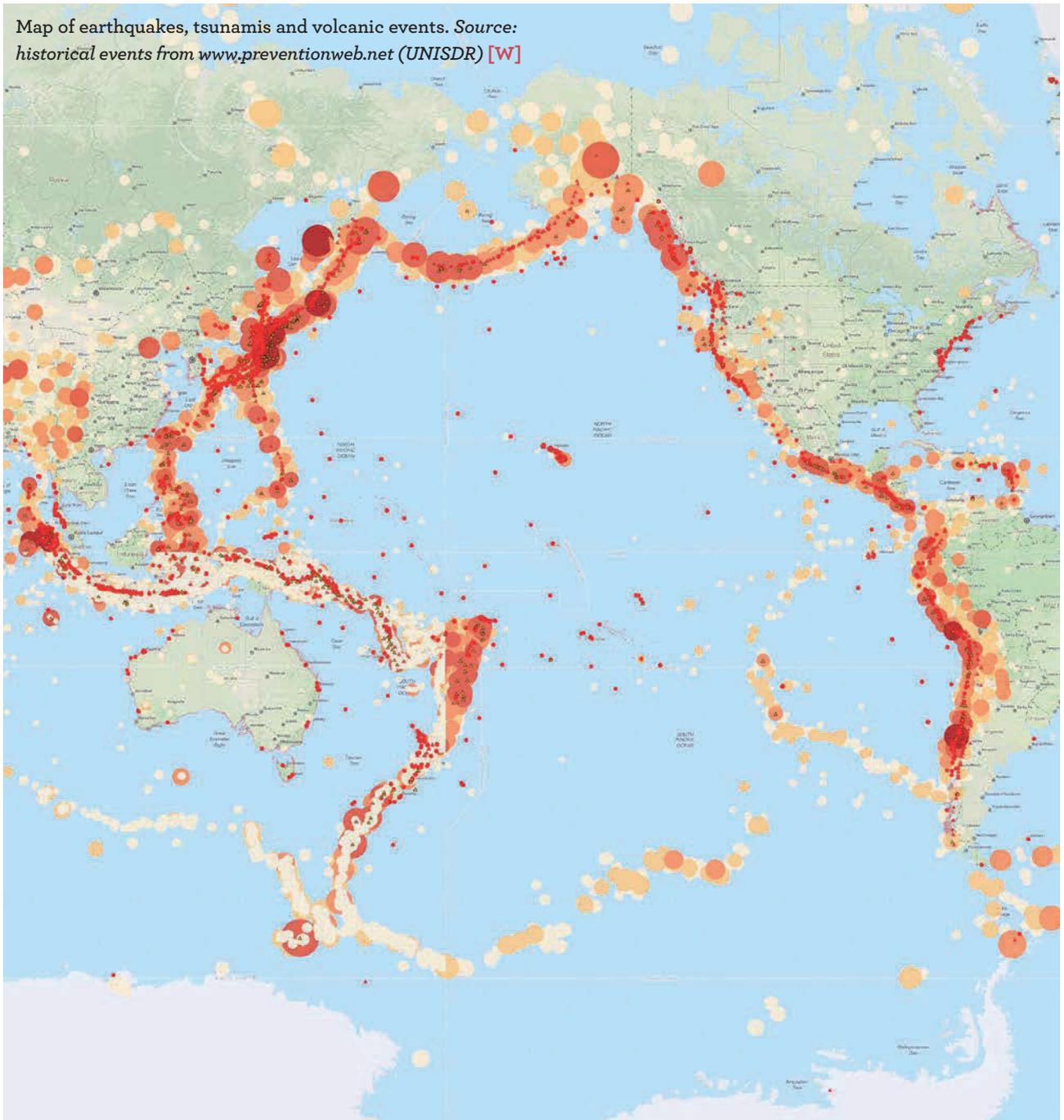


FIGURE 21: Asia-Pacific dominates hydro-meteorological and geophysical hazards.

are particularly vulnerable, with the risk of a large percentage of the population being killed by a single event resulting in severe socio-economic consequences.

Figure 22 quantifies the impact of disasters on APRU economies over the past 15 years and identifies the relative impacts of different classes of disaster. Geophysical events have been responsible for over 70% of deaths in the region, while meteorological events have caused the most economic damage overall. Hydrological events have affected the most people.³⁴ Note figures are over a longer time period than global data previously highlighted.

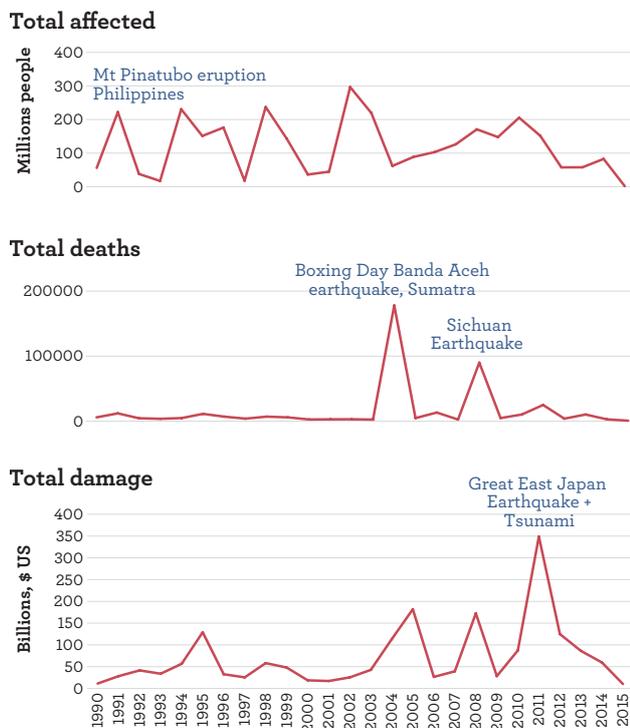
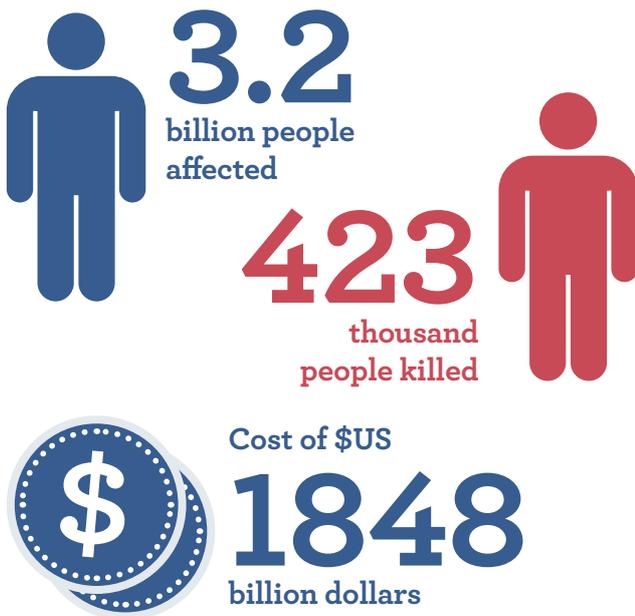


FIGURE 22: High vulnerability of Asia-Pacific nations – impact of disasters in the Asia-Pacific region, 1990-2015. Data: EM-DAT [P]

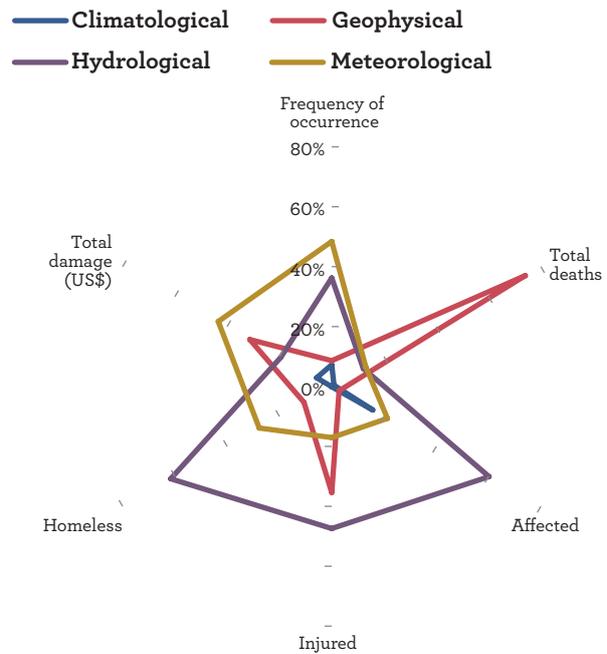


FIGURE 23: Relative impact of disasters (by type) within the Pacific Rim region – different hazards have different impacts. Data: EM-DAT [P]

3.2 APRU research strengths – geophysical, meteorological & hydrological hazards

This section delves in greater detail into APRU’s research strengths in the fields of geophysical, meteorological and hydrological hazards, presenting data which compares performance to the global average and other economies and groups. For each hazard area, keyword analysis of the SciVal database was used to define worldwide papers falling into each category.^{IV} This method was necessary as the complete collection of such papers stems from a range of disciplines and journals. This dataset was then analysed for the presence of and output from APRU institutions, and a sub-group of APRU-only research was created. All statistics presented in this section originate from this analysis. See footnotes for keywords used in each case.

As evidenced by Figure 24 APRU research is widely cited, viewed and produced with a high degree of international collaboration. All metrics in these figures are benchmarked such that a value of 1 is equal to the average global performance (a value of 2 therefore represents twice the global average).

3.2.1

Geophysical hazards:^V scholarly output

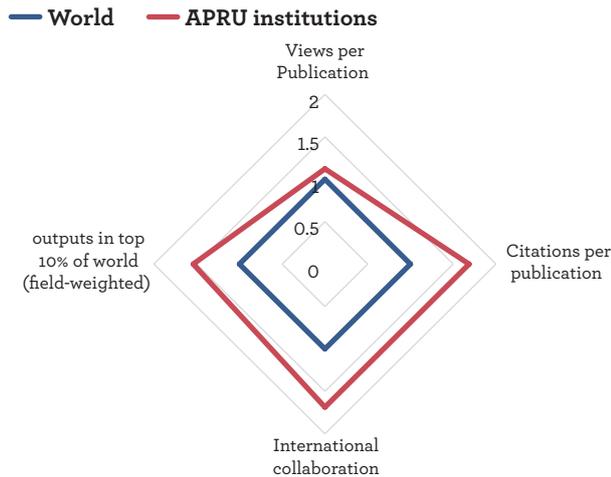
Institutions in the 17 APRU economies are involved in over 68% of research in geophysical hazards. APRU has 19 institutions in

^{IV} See reference section for further information.

^V Scholarly output on ‘geophysical hazards’ is defined here as publications which include the keywords: earthquake(s) or tsunami(s) or eruption(s) & volcano(es).

Scholarly output:

Tectonic hazards



Scholarly output:

Meteorological & hydrological hazards

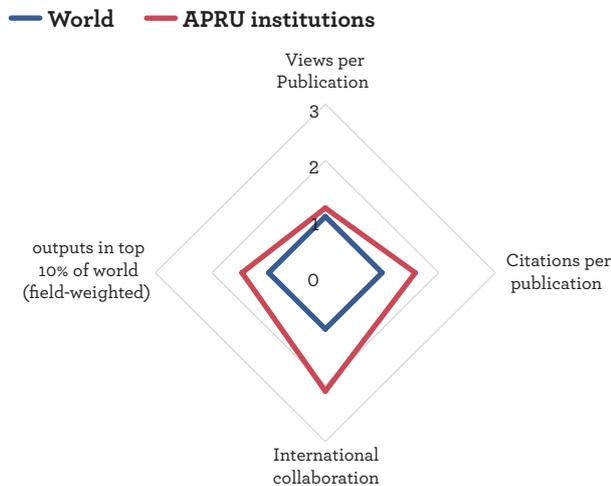


FIGURE 24: Performance on research metrics for tectonic, meteorological and hydrological hazards relative to the world average shows APRU's strengths. All metrics benchmarked such that the world average value equals 1. *Data: SciVal [A]*

the top 100 institutions on this topic (by scholarly output), and four institutions in the top ten (including Tokyo, Tohoku, Kyoto and National Taiwan University). APRU institutions in Chile, Mexico and New Zealand are also the top institutions in this list for their respective economies in terms of scholarly output, with University of Auckland and National Autonomous University of Mexico (UNAM) both in the top 30 worldwide.

Of the top 100 institutions globally in this topic by scholarly output, APRU produces 23% of the publications, 28% of the citations and 25% of views.

Figure 25 identifies the most common keywords for APRU institutions in the area of geophysical hazards, with the size of the word proportional to frequency. The colour is proportional to the growth in output of this keyword over the period 2010-2014, darker colours represent faster growth.

Figure 26 displays the scholarly output in geophysical hazards against a quality proxy (field-weighted citation index (FWCI)) for organisations in North America and Japan in the top 100 globally in this area. APRU institutions are shown in red while other top institutions including research institutes, government agencies and geological societies are marked in blue. APRU institutions are prolific producers in this field, while retaining quality typically well above the world average (represented by a FWCI of 1).

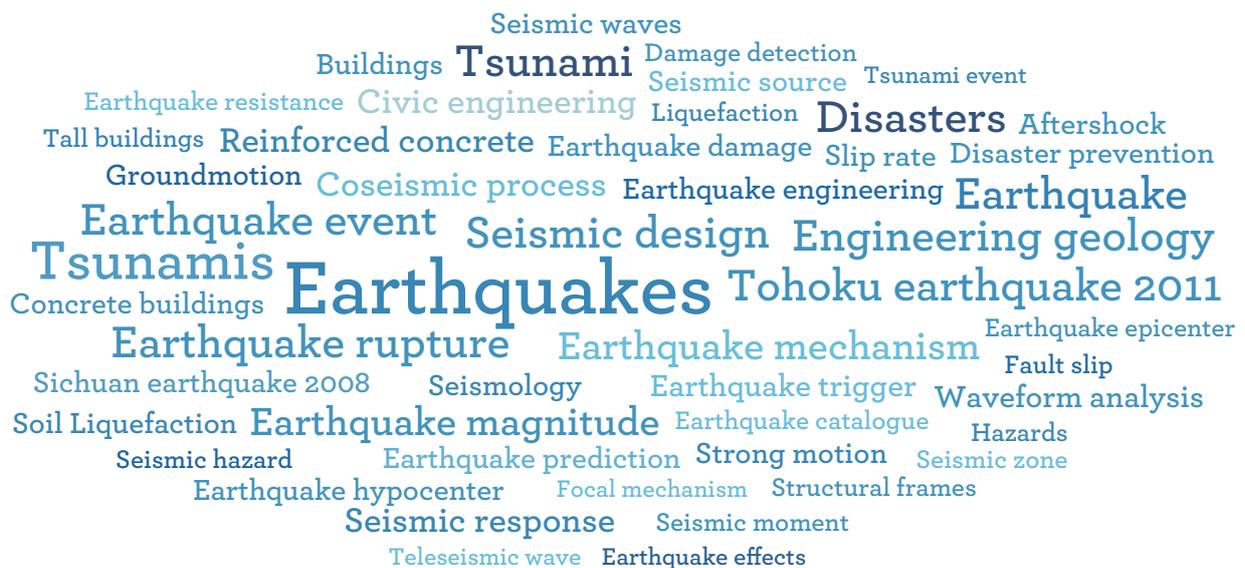


FIGURE 25: Word cloud for APRU papers identified as covering 'geophysical hazards' with frequency of keyword represented by size of font. Darker colours represent increasing frequency over time. *Data: SciVal [A]*

3.3 APRU activities & impact in disaster risk management

3.3.1 Education & capacity building – enhancing disaster preparedness and resilience

APRU institutions are highly active in promoting public education and awareness in disaster risk reduction (DRR) across all age groups. In addition, institutions provide specialist training for emergency managers and first responders as well as general education on disaster risk reduction for students.

STUDY 17 Education for disaster risk reduction

Child and Community Education – Earthquakes and Tsunamis, Tohoku University

CONTEXT: The International Research Institute of Disaster Science (IRIDeS) of Tohoku University developed several DRR educational materials in collaboration with local governments, the private sector and academia to distribute to communities in affected areas to raise their awareness of DRR and preparedness. These materials include a DRR handbook for all families and a handkerchief for school children. School children can be a particularly vulnerable group in disaster-prone areas. Communications material and learning aids need to be designed for this target audience.

OUTPUT: A handkerchief has been developed and given to school children to teach them about disaster preparedness.



Educating School Children on Development and Resilience in the Face of Climate Change & Extreme Weather, University of the Philippines (UP)

CONTEXT: As a further example of a learning aid customised for its target audience, “Survive and Thrive”™ is a table-top card game that aims to teach its players the lessons of balanced development and resilience under the climate change lens.

INITIATIVE: This ingenious product is the brainchild of the BaR-C2 Project of UP in collaboration with Balangay Entertainment. The goal is to introduce the concept of climate change and extreme weather to young people. It is envisaged that schools will use the game as part of their curriculum. Both titles in this box have been supported by research grants by the Commission on Higher Education (CHED) of the Philippines.

Training & Education on Disaster Risk and Resilience, University of Hawai’i at Mānoa (UHM)

CONTEXT: UHM, with support from the United States Agency for International Development (USAID) and several other non-governmental organisations, has been engaged in research, education, and training in the Asia-Pacific region on disaster risk reduction and resilience.

COLLABORATION: UHM hosts, with the United Nations University (UNU), an international training program known as the Asia-Pacific Initiative, and also works closely with universities in Indonesia, Bangladesh, Vietnam, and the Philippines to share and develop a disaster resilience training curriculum. UHM has played a coordinating role and has educated many students and learners throughout the Asia-Pacific region, working with emergency managers, first responders, utilities and agencies and, importantly, at-risk communities.

OUTCOMES: The initiative has expanded the curriculum and training in hazard-prone regions. It brings together academia, governments, NGOs, and community members to work collaboratively on identifying risks and vulnerabilities, and developing mitigation strategies.

The benefits include the improved curriculum and the raised profile of risk reduction and, specifically, coordination and sharing of information, improved training and educational programs, improved quality of teaching, research initiatives, engagement with international partners and scientific organisations involved in disaster risk reduction, and integration with urban planning and development.

3.3.2

Creating and maintaining knowledge – learning from events, understanding disaster risk

APRU institutions perform cutting-edge research to understand disaster risk, for example on the mechanisms behind earthquakes or the behaviour of materials exposed to such stresses. An analysis of academic strengths in the areas of geophysical, meteorological and hydrological hazards can be found later in this chapter.

Institutions also play a key role in gathering data on events to enable us to learn from the past.

STUDY 18

Learning from events

Sharing Lessons Learned from the Great East Japan Earthquake & Tsunami (GEJET), Tohoku University

CONTEXT: The International Research Institute of Disaster Science (IRIDeS) of Tohoku University, in collaboration with Harvard University, has developed an archiving system for various types of materials such as photos, videos, and interviews, to preserve experiences and lessons learned from GEJET.



SHARING KNOWLEDGE: The archiving system can be used for educational materials and for research by future generations. The records are accessed through the website and at national and local libraries.

FORUM: The digital archiving system also aims to provide a public space for information-sharing, collaboration and conversation by citizens, researchers, students and policymakers. Such a system has not existed before. It is one of the important roles of universities to preserve these materials and pass on the lessons learned to the next generation.

3.3.3

Applying knowledge to societal challenges

There is an imperative to direct researchers' skills and knowledge to work with policymakers and government agencies to apply knowledge and improve preparedness for disasters, and provide technical or engineering solutions, both to reduce the potential impact of events (e.g. through improved construction) and assist with disaster relief.

STUDY 19

Providing early warning systems and disaster management tools

Earthquake & Tsunami Forecasting and Risk Analysis, University of California, Davis (UC Davis) and Collaborators

CONTEXT: The past decade has witnessed a terrible loss of life related to large earthquakes and resultant tsunamis in the Indo-Pacific region. Technology based on Global Navigation Satellite System (GNSS) data and science now exists to detect tsunamis from earthquakes and to track them using the associated coupled ionospheric waves. These activities are aided by the development of practical, real-time earthquake forecasting technology that can be globally deployed.

COLLABORATION/COMMERCIALISATION: Multiple institutions have collaborated including Tohoku University, National Taiwan University and UC campuses including Davis and Irvine. The forecasting technology has been implemented not only at a research level by APRU institutions, but also by commercial spin-offs such as the Open Hazards Group of UC Davis (www.openhazards.com).

The activity has been successful as a result of APRU institutional involvement and support for workshops such as the recent APEC Cooperation for Earthquake Simulations International symposium in Chengdu, China, 10-14 August 2016.

OUTCOMES: The science and data are currently available to develop and deploy an operational prototype of a GNSS tsunami early warning system. Currently planned activities involve international workshops for planning, organisation, and coordination, software development, education and the deployment of additional GNSS stations and satellites at test locations on the Pacific Rim, primarily in Asia (Japan/Chinese Taipei/Indonesia), together with development of necessary data sharing agreements. An operational prototype is scheduled to be deployed by 2020.

Earthquake Early Warning Systems, University of Oregon (UO), University of Washington (UW) and Collaborators

COLLABORATION: With the recently expanded and growing seismic network (see page 17), UO and UW have partnered with APRU members University of California, Berkeley and California Institute of Technology to develop ShakeAlert, an Earthquake Early Warning system.

INITIATIVE & OUTCOMES: This system uses real-time data collected by Pacific Northwest Seismic Network stations to rapidly detect and locate earthquakes, estimate magnitude and ground shaking, and issue warnings seconds to minutes before strong shaking occurs. Such technology can be used to prevent damage to infrastructure and warn the public of impending strong ground motion and tsunami potential in their particular location.

Disaster Monitoring and Response Systems (DMRS) for Asia, University of Hawai'i at Mānoa (UHM)

Establishment of the ASEAN Humanitarian Assistance (AHA) Centre

CONTEXT: The DMRS was built to provide the AHA with disaster monitoring, early warning, and decision support capabilities for all ASEAN Member States, serving over 625 million citizens in Southeast Asia. The information and control centre was built in Jakarta to provide humanitarian assistance coordination with the national disaster management offices of all ten ASEAN Member States. The Pacific Disaster Center (PDC), a program of UHM, was integral to the development and deployment of the DMRS and in training of personnel at this centre.

IMPLEMENTATION: PDC worked closely with the AHA Centre from concept evaluation, through installation of the PDC base DisasterAWARE platform and customisation, to application and institutionalisation. Data, hazard models, applications, and security components were seamlessly integrated, and AHA Center staff were trained in the use and maintenance of the system. The success of the project



required an in-depth understanding of disaster management processes, and the ability to convey these to intended system users via formal training methods and standard operating procedures (SOPs). A Train-the-Trainer course was delivered to ensure that the AHA Centre is able to maintain a cadre of well-trained staff that will be able to operate DMRS well beyond the original life of the project.

Enhancing disaster management and decision support capacity in Indonesia

IMPLEMENTATION: Custom versions of the DisasterAWARE platform were also developed for Indonesia, Vietnam, and Thailand, and deployed at the respective national disaster management agencies, for use by national and provincial stakeholders. As with DMRS, deployments were accompanied by user and system training and the development of institutional mechanisms such as SOPs. Table-top exercises were developed to reinforce skills. A group of national trainers has since delivered training at the provincial levels, expanding access to the benefits of the system.

OUTCOME: Early warning and disaster management (DM) decision-making outcomes in Southeast Asia and across the region have been improved through enhanced capacity within DM organisations; improved access to automated international, regional and national hazard information; better information-sharing between agencies; and more effective dissemination of alerts and warnings to at-risk communities.

STUDY 20

Strengthening disaster risk governance

Support for the Recovery Work of Local Governments Affected by the Great East Japan Earthquake and Tsunami (GEJET), Tohoku University

CONTEXT: The International Research Institute of Disaster Science (IRIDeS) of Tohoku University aims not only to conduct thorough research on GEJET, but also to make the best use of the research outcomes and contribute to implementation. This is achieved through dialogue and collaboration with local governments and communities.

COLLABORATION: IRIDeS has made a series of contributions to the recovery process of GEJET by working with local governments, for instance:

- In collaboration with the private sector, IRIDeS provided scientific and technical advice on evacuation drills conducted at affected cities and towns to make the drills more practical,
- IRIDeS made an agreement (MOU) with affected local governments to strengthen their collaboration in the recovery process and support each other to build resilient communities against natural disasters.

OUTCOMES: University resources and research/knowledge have been successfully applied to disaster recovery.

The ultrafiltration system separates out bacteria and viruses to produce potable water, up to 5,000 litres per day in eight hours' operation.

For disaster relief, the system is installed with a mobile lab that tests the treated water with a 15-parameter diagnostic, including pH, turbidity, heavy metals, bacteria, pesticides and others. The system has a lower cost and is easier to maintain than reverse osmosis, ultra violet and nanofiltration systems.



See also Appendix 7.1 for a summary of University of Oregon's collaboration with the Earth Observatory of Singapore to build an integrated analysis and mapping tool to forecast natural hazards.

3.3.4

Connectors & cultural bridges

Various APRU institutions have established expertise and resources in relation to disaster risk reduction and natural hazards. Initiatives exist to ensure this knowledge is spread throughout the Asia-Pacific and disseminated to those best placed to implement necessary changes. These connections and bridges are evident in Studies 17-20.

STUDY 21

Engineering solutions for disaster relief

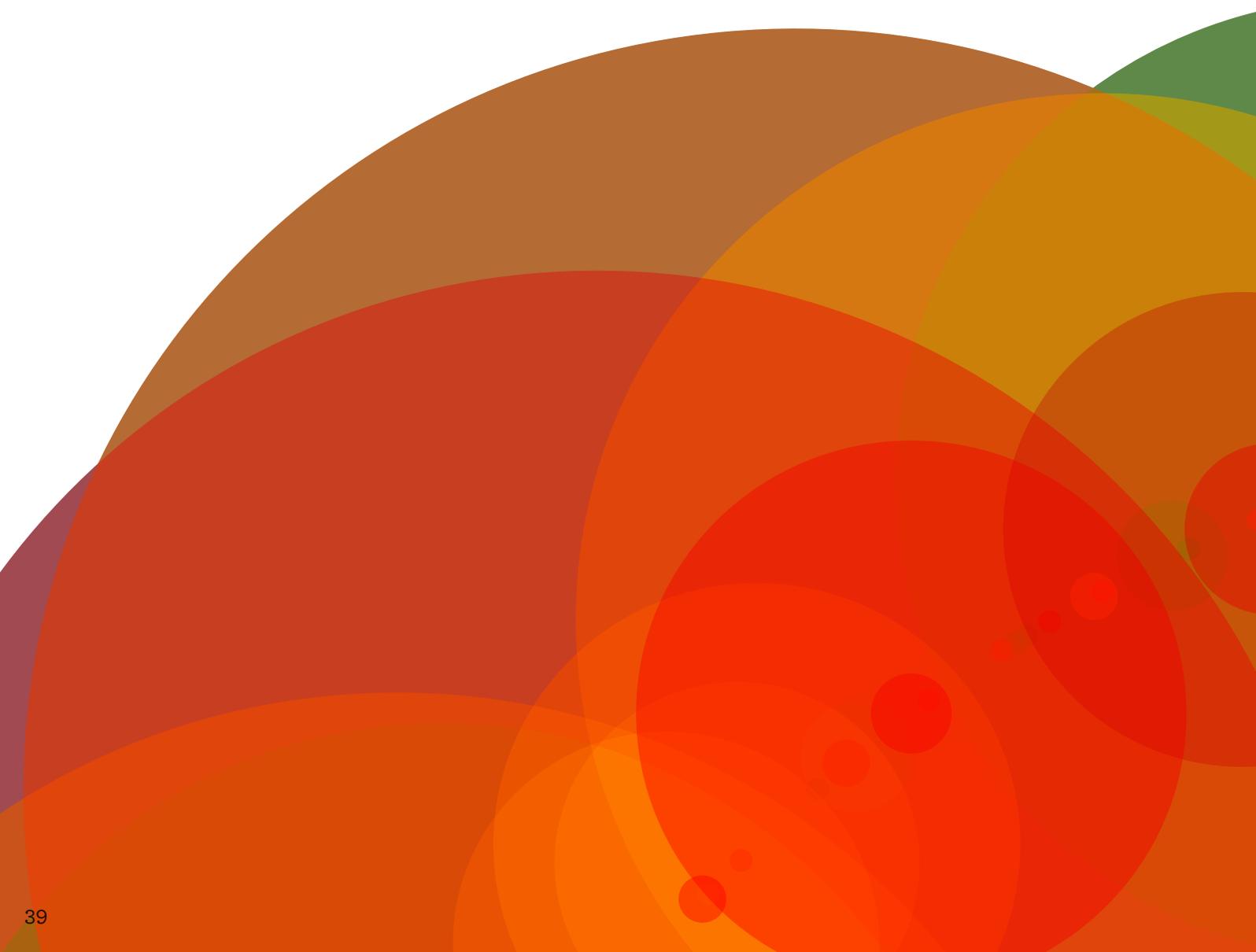
Water Supply for Disaster Relief, University of Malaya

CONTEXT: Maintaining water supply after a natural disaster is often a critical task. A team of researchers from the University of Malaya designed a mobile ultrafiltration system that uses solar power for automated self-cleaning of water.

SOLUTION: The system designed is capable of treating river, rain or waste water to produce good drinking water especially for disaster relief. It was successfully installed and used to help victims of the flood disaster in 2014 that affected the east coast of Peninsular Malaysia. This system was much needed as the severe flood had damaged almost all water treatment plants due to mudslides or the heavy flow rupturing many old underground pipes.

4.

IDENTIFYING AND REVIEWING STRENGTHS WITHIN APRU



As identified under the 'knowledge creators' role described in Chapter 2, APRU as a collective group displays strong performance across all metrics of academic knowledge production (efficiency, visibility, citations, reach). Research performance in the multidisciplinary area of natural hazards and disaster risk reduction was also reviewed as a specific theme under Chapter 3. This chapter delves in greater detail into APRU's other collective research strengths and provides examples of synergies and complementarity for constituent institutions. Section 4.1 reviews APRU's strengths in terms of research quality, quantity and how such metrics are evolving through time while section 4.2 looks at APRU's strengths from a different angle, specifically considering collaboration with industry and metrics surrounding innovation.

4.1 Research

Section 4.1.1 examines collective performance across the range of disciplines and identifies specific areas of combined expertise. Trends in performance through time are then presented to consider how these strengths are evolving. Finally, Section 4.1.5 considers differences in specialisation among the group and provides examples where institutions have complementary capabilities.

All statistics and charts shown in this chapter are derived from analysis of SciVal and Scopus data, provided courtesy of Elsevier (see References).

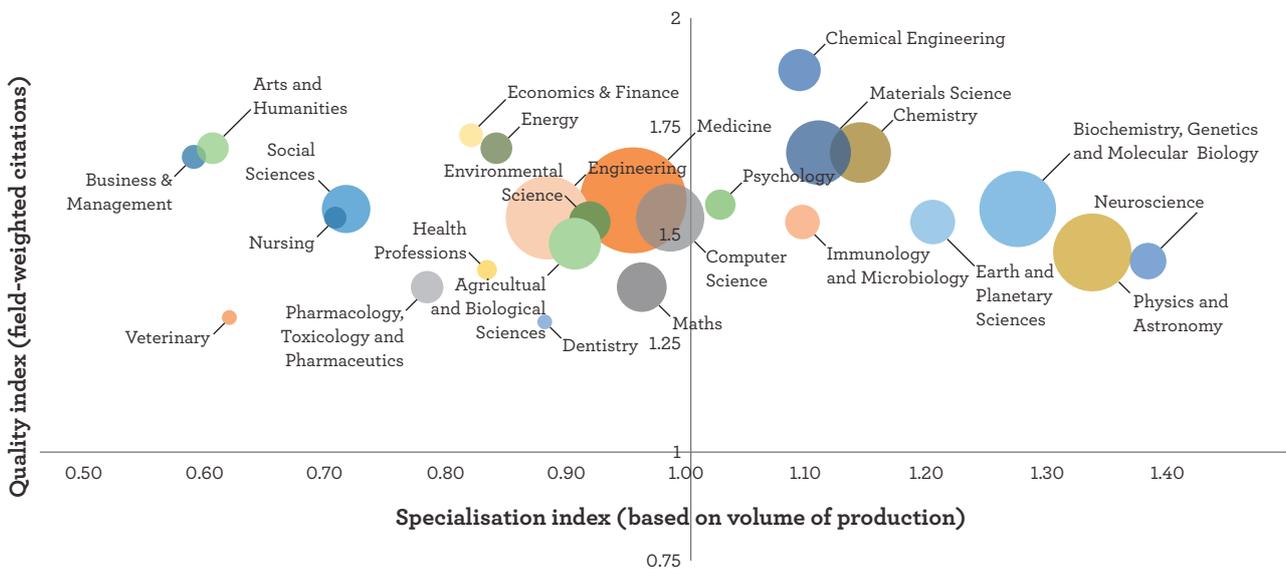


FIGURE 28: Research by APRU institutions by discipline, considered in terms of quality (measured by citation) and degree of specialisation (% of publications by APRU in discipline/% of publications in the world in discipline). Data: SciVal [A]

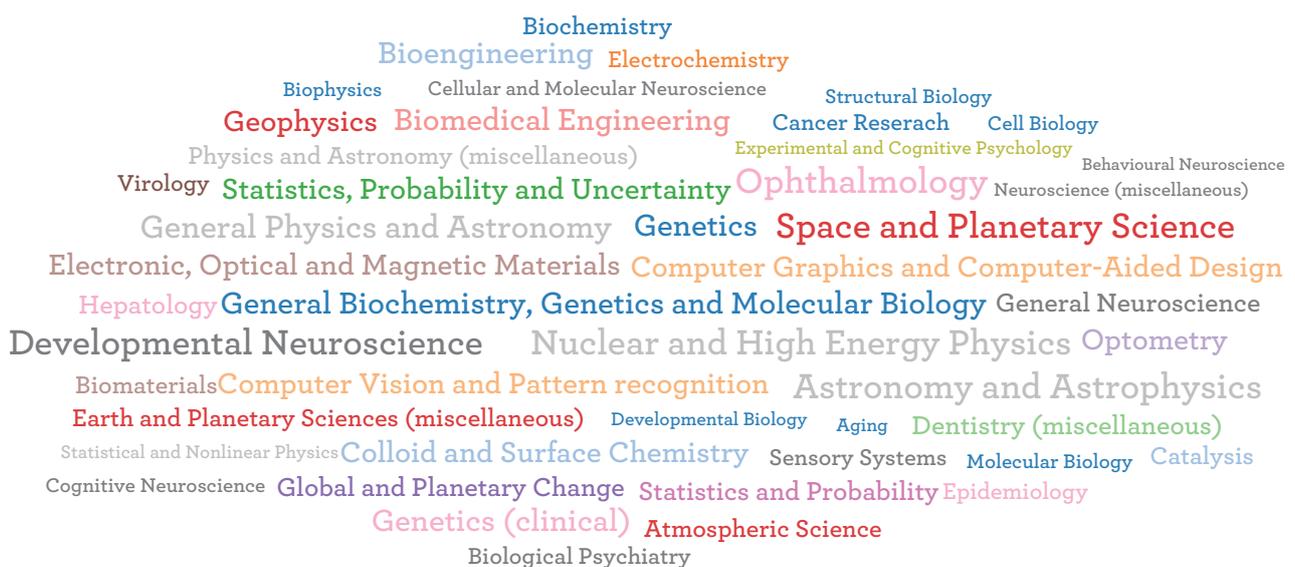


FIGURE 29: APRU sub-disciplinary strengths, top 50 sub-disciplines by volume (relative to world output in the area), text size proportional to citations per paper (relative to world citations per paper), coloured by discipline. Data: SciVal [A]

4.1.1

Strengths in 2016

Figure 28 represents APRU's collective strengths at a disciplinary level. All subjects are substantially above the global average field-weighted citation index (FWCI), a proxy for overall quality of the research conducted. A FWCI value of 1 represents the global average and is marked by the intersection of the axes. Similarly, a specialisation index of 1 for a discipline (where the y axis crosses) implies that the volume of output as a share of total output by APRU is equivalent to the same ratio at world level.

At a sub-disciplinary level some more specific areas of strength are identified. The top 50 sub-disciplines as identified by percentage of APRU world output in that area are represented in Figure 29. The size of the text is proportional to a quality indicator, while the colour correlates to the overarching discipline in which it is situated.

4.1.2

Highly visible research

APRU research is highly viewed relative to other world research output; despite having only 6% of the authors, approximately 11% of global views of publications are of APRU work. In all disciplines the numbers of views and publications are high compared to the proportion of authors. Figure 30 compares actual views by discipline with the APRU average for all disciplines, and compares this data with the number of APRU authors in the discipline as a percentage

APRU group, % of world total (2010-14)

- % of world views for discipline
- - - % of world total for APRU (all disciplines)
- % of world authors for discipline
- - - % of world total for APRU (all disciplines)

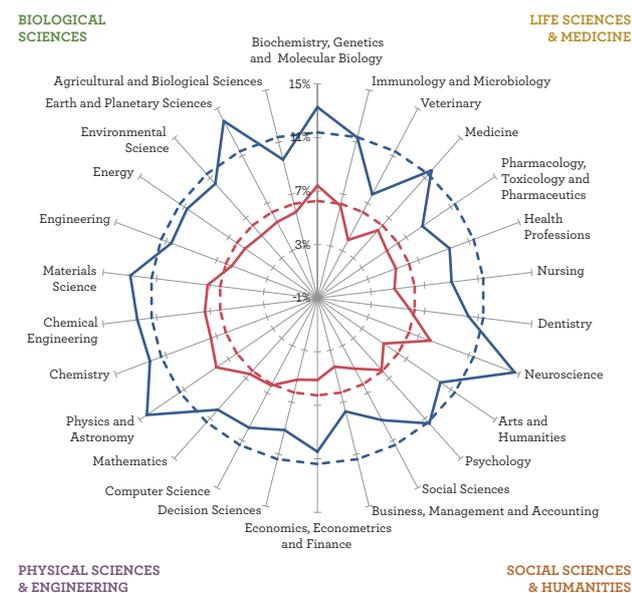


FIGURE 30: High share of world views of publications for all disciplines for APRU, particularly considering the number of APRU authors. Average views across all disciplines shown by dotted lines. Data: SciVal [A]

of the world total. Most peaks coincide, however, earth and planetary sciences receive a much higher view count relative to the number of authors (and indeed publications).

An alternative way to consider visibility is to look at rankings of publications by media visibility, as measured for example by the company Altmetric.^{vii} In 2015, 29 of the top 100 papers identified worldwide by Altmetric contained an author from an APRU institution.

4.1.3

Highly cited work from productive authors

Not only are APRU authors highly productive, producing highly visible research, but their work is well cited across all disciplines. All subjects have a higher share of citations than expected from the percentage of world output. Earth and planetary sciences become an even more noticeable peak.

4.1.4

Recent trends in research performance

Figure 31 explores how performance is changing over time considering two recent time periods. Scholarly output is increasing overall; as the data presented in the chart is relative to the world, it is possible to increase volume of scholarly output in an area but display a decreasing share in the chart on the next page. This is true for example for APRU output in earth and planetary sciences, engineering and environmental sciences. It is therefore all the more impressive that in 11 disciplines APRU institutions have not only outpaced global publication growth in the area but also continued to increase the relative quality of their work. The physical sciences in particular have seen an improvement in quality as measured by their field-weighted citations (Figure 33).

Change in citation impact relative to world (FWCI)

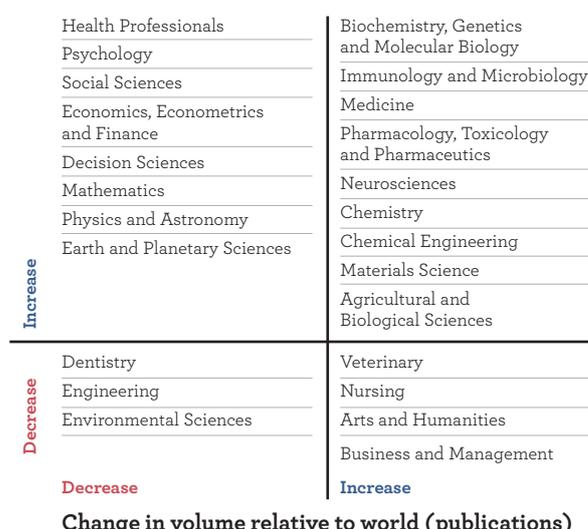


FIGURE 31: APRU change in performance (relative to global change) by discipline between 2004-2008 and between 2008-2012 shows the growing strength of APRU life sciences and physical sciences. Data: Elsevier [A]

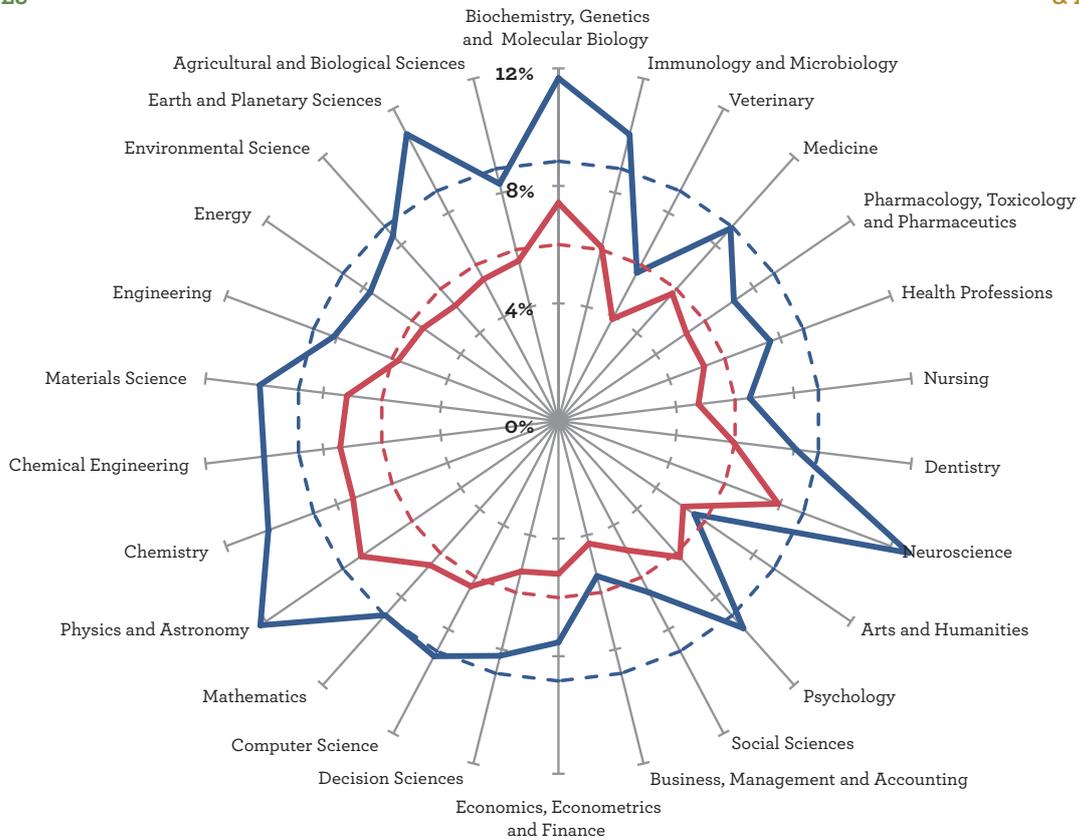
^{vii} Altmetrics are non-traditional metrics and include news stories, blogs, tweets, Facebook posts, Google+ posts and Reddit posts on articles. For further information on method and the company see www.altmetric.com.

APRU group, % of world total (2010-14)

- % of world publications - - % of world total for APRU (all disciplines)
- % of world authors - - % of world total authors for APRU (all disciplines)

BIOLOGICAL SCIENCES

LIFE SCIENCES & MEDICINE



PHYSICAL SCIENCES & ENGINEERING

SOCIAL SCIENCES & HUMANITIES

FIGURE 32: Share of citations of APRU publications is significantly higher than their share of world output, for all disciplines. Average citations across all disciplines shown by dotted lines. Data: SciVal [A]

Output as % of world

Quality proxy: field-weighted citation index

- 2008-2012 — 2004-2008

- 2008-2012 — 2004-2008

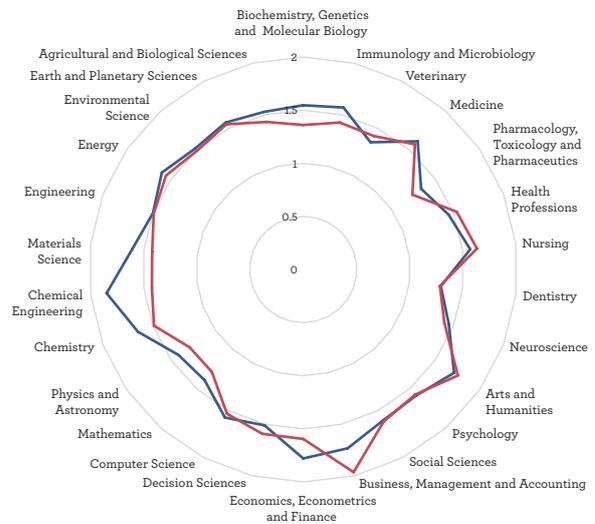
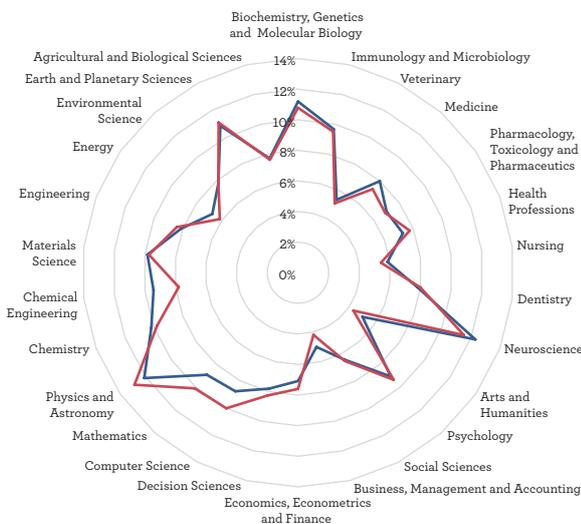


FIGURE 33: APRU publication volume and average quality (as reflected by the field-weighted citation index) by discipline, 2008-2012 versus 2004-2008. Data: Elsevier [B]

4.1.5

Variation within APRU: complementary & synergistic opportunities

Like the Asia-Pacific region, APRU is a diverse group and is stronger due to this diversity among its members. Figure 34 quantifies the variety of emphasis on research output by discipline within APRU, the range for each discipline showing the spread in specialisation for the different institutions relative to the average distribution of research globally. The largest areas of difference are in medicine. Not all APRU institutions have a medical school while some have a relative specialty in this area (including UCLA, University of Melbourne, University of Sydney, University of Washington and USC). The majority of APRU institutions have above average emphasis on earth and planetary sciences, as might be expected from the setting. Relative specialisation in physics and astronomy is also common. Engineering is another point of difference among the group with institutions such as HKUST and Tsinghua University specialising in this field.

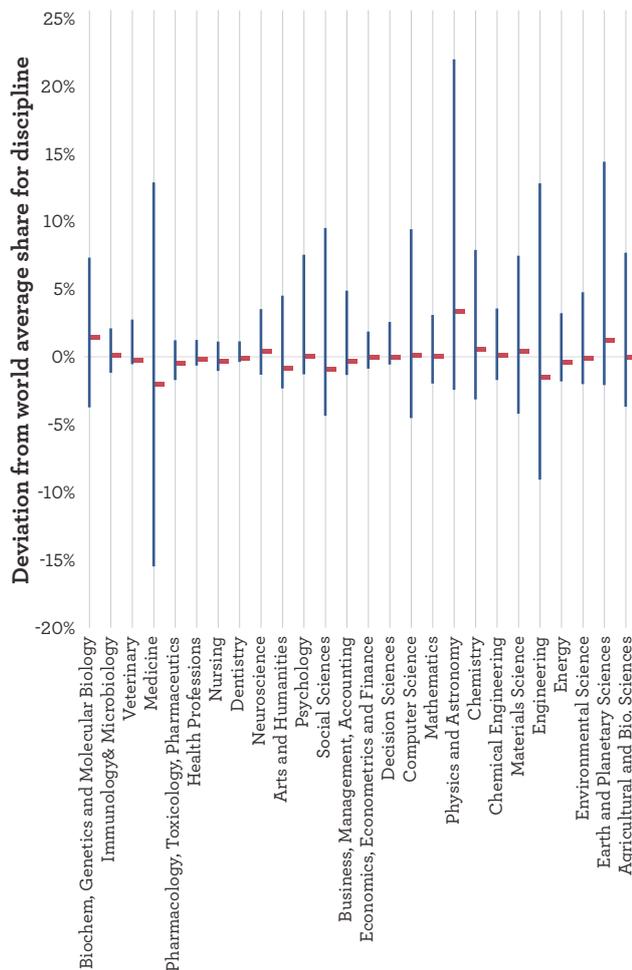


FIGURE 34: Specialisation and variation in research output across APRU institutions. Measured by % difference from world publication volume in each discipline. Error bars indicate max and min deviation from world publication volume for all institutions. *Data: SciVal [A]*

This variety results in institutions with complementary strengths in some areas and potential synergies in others. Figure 35 uses NUS and UCLA as examples. NUS' focus on computer science and materials science complements UCLA's relative specialisations in medicine and psychology. Areas of potential synergy include biochemistry, genetics and molecular biology.

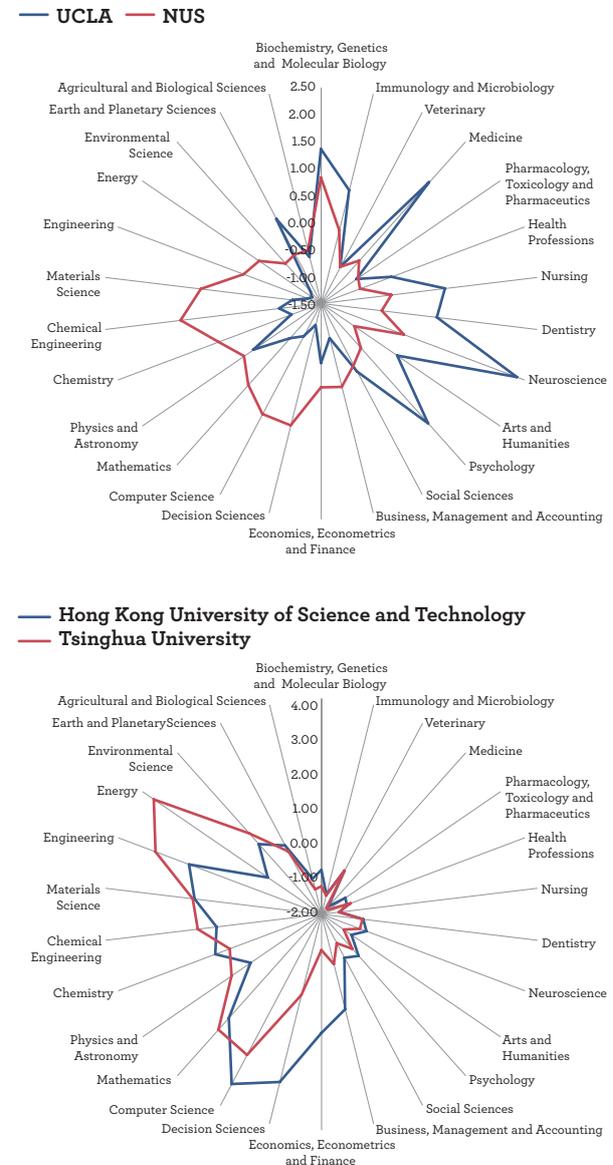


FIGURE 35: Specialisation of certain institutions within APRU. Measured by difference (in standard deviations) from APRU average publication share for that discipline. Two complementary institutions shown (top) and those with similar specialisations (below). *Data: SciVal [A]*

4.2

Innovation and innovation ecosystem strengths

High quality research and the production of talented graduates have helped support the innovation ecosystems surrounding APRU institutions. Several proxies provide evidence of the use of APRU research by companies, including patent citations and academic-corporate collaboration. APRU institutions perform well above the world average of patent citations across all disciplines when the volume of scholarly output is taken into account (Figure 36).³⁵

Academic-corporate collaboration data shows an elevated rate of collaboration across all disciplines, compared with the world average (Figure 37). Collaboration varies significantly by discipline and generally follows a similar pattern to global trends (the average collaboration rate across all disciplines is represented by the dotted line). Collaboration is particularly strong in the fields of engineering, materials science, energy and computer science. As highlighted previously this data is based on co-publication with industry and therefore is likely to be an underestimate of real world collaboration.

Patent citations per scholarly output

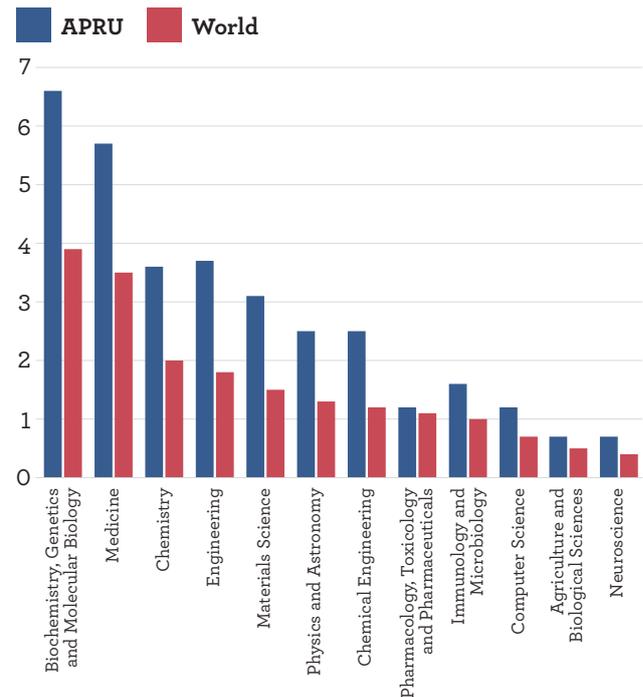


FIGURE 36: APRU patent citations per scholarly output (thousands) are high compared with world levels, corrected for publication output. Data: SciVal [A]

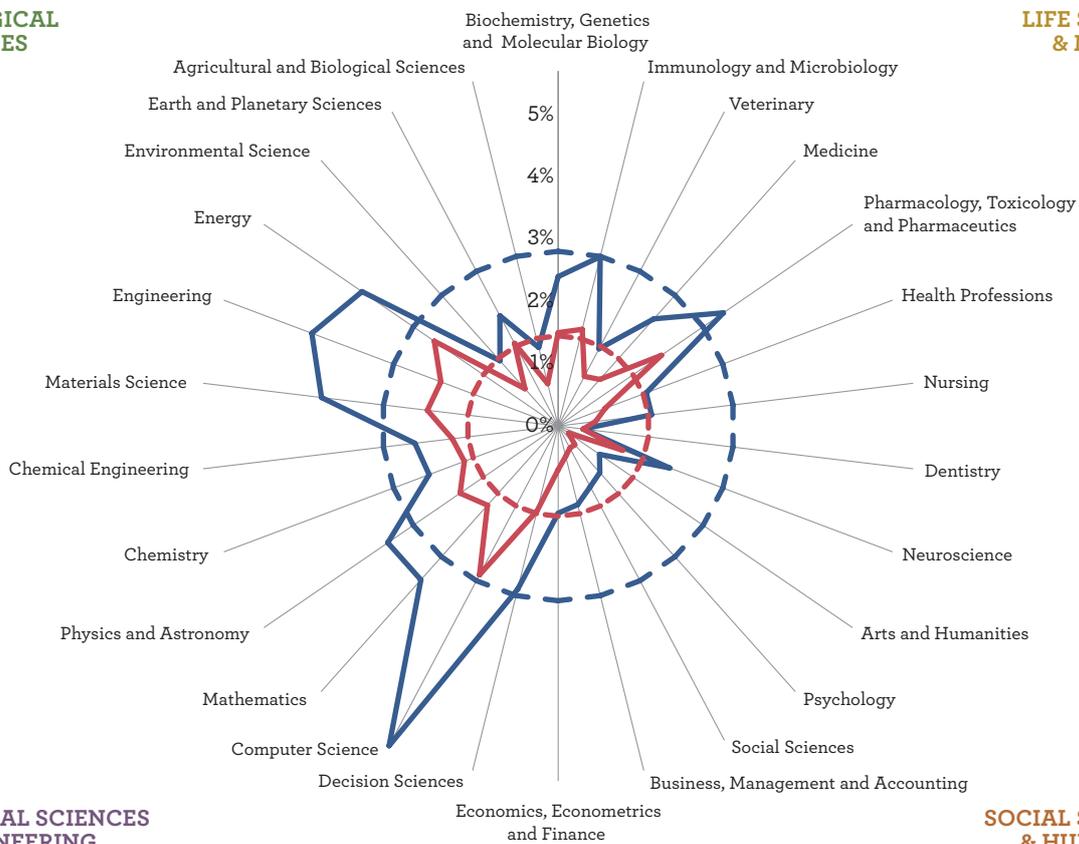
APRU group, % of world total (2010-14)

— APRU academic-corporate collaboration (%)
 - - - % of world total for APRU (all disciplines)

— World academic-corporate collaboration (%)
 - - - % of world total for APRU (all disciplines)

BIOLOGICAL SCIENCES

LIFE SCIENCES & MEDICINE



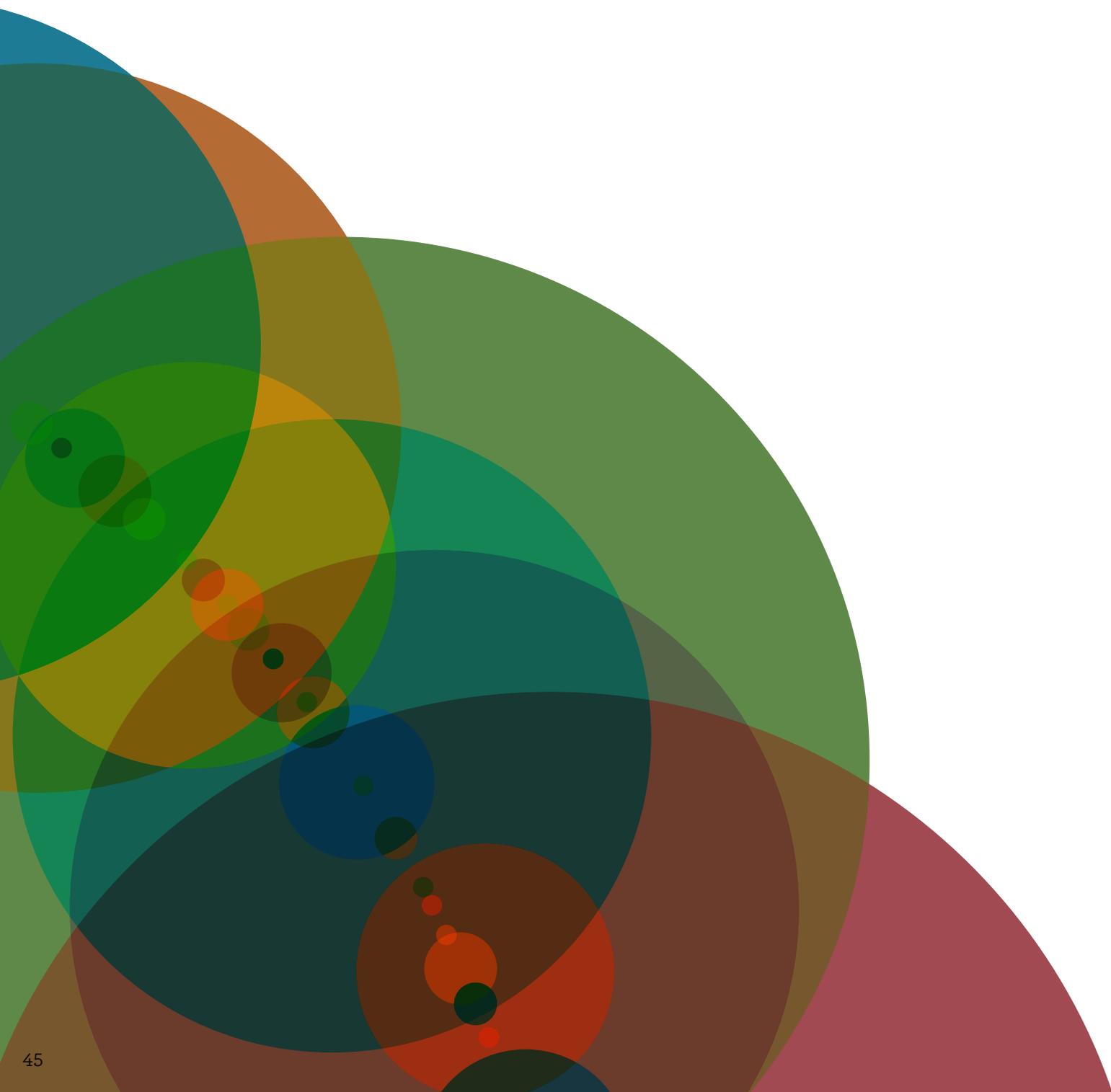
PHYSICAL SCIENCES & ENGINEERING

SOCIAL SCIENCES & HUMANITIES

FIGURE 37: Academic-corporate collaboration (co-publication by discipline) for APRU is high compared with world levels across all disciplines. Average collaboration across all disciplines shown by dotted lines. Data: SciVal [A]

5.

COLLABORATION IN THE APRU NETWORK



This section explores local and international collaboration across the APRU network and considers the benefits obtained from such collaboration from an academic research perspective. Cutting-edge research and the complex problems faced by society today also often require an interdisciplinary approach. Here APRU institutions are taking a lead, as evidenced by Section 5.2.

Finally, linking back to areas of academic strength highlighted in Chapter 4, a ‘deep dive’ is performed on a sub-discipline where APRU institutions are collectively strong to explore how these top institutions collaborate.

5.1 Collaboration within APRU

The following diagram shows the extent of current collaboration on research between APRU members and has been calculated using publication data from Elsevier. Each connection between institutions is represented by a line, the relative thickness of which is proportional to the volume of collaboration between the two institutions.

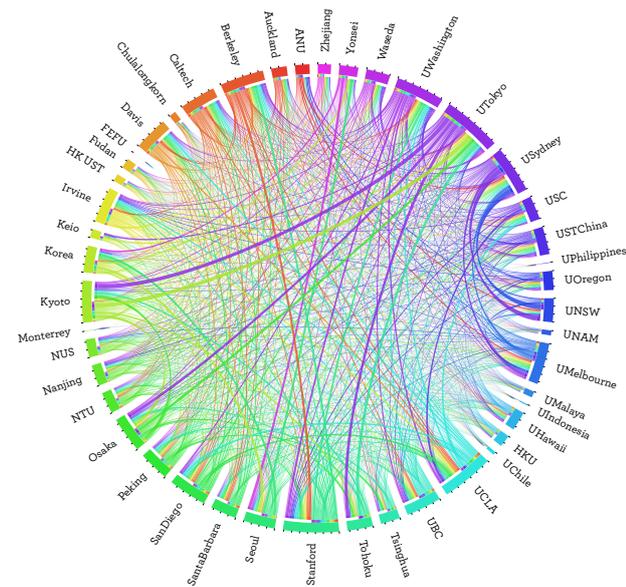


FIGURE 38: Papers produced collaboratively between researchers at APRU institutions (2010-2014). Thickness of line proportional to volume of collaboration between connecting players. Data: SciVal [A]

Benefits of APRU collaboration

Most APRU institutions see an increase in citations (corrected for field and publication age) for publications produced with another APRU institution relative to other collaboration nationally, as shown by Figure 39.

Institutions with a high share of publication collaboration with other APRU institutions (>15% of collaborative publications) include HKUST, University of Indonesia and UNSW. University

of Hong Kong, Fudan, University of Auckland, UBC, NTU, and University of Chile are all examples of institutions which see a particularly significant benefit in citation rates from their collaborations with other APRU institutions.

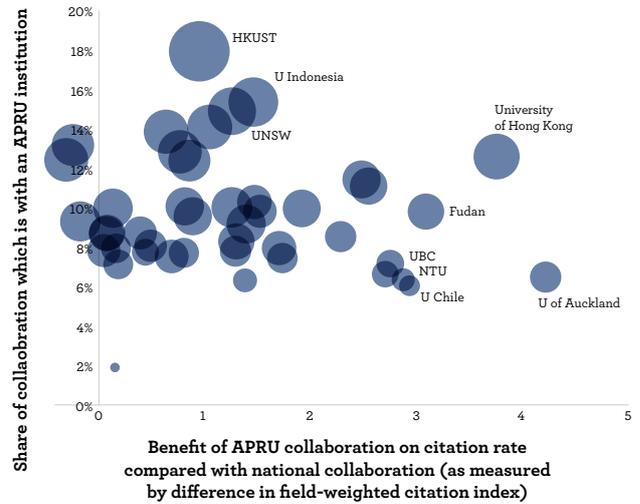


FIGURE 39: Share of collaboration which is within APRU versus ‘citation boost’ for APRU collaborations compared to national collaboration. Bubble size reflects prevalence of collaboration with APRU institutions (as a share of all collaborating authors). Data: SciVal [A]

APRU institutions – bridging gaps across the Asia-Pacific region

The following figure only considers collaboration between APRU institutions which is international. Some universities have a high volume of collaborations with other APRU institutions, most notably UBC, and Universities of Melbourne, Tokyo and Sydney. Others show a high diversity in their collaborations, playing a connective role across the region, examples include NUS and NTU.

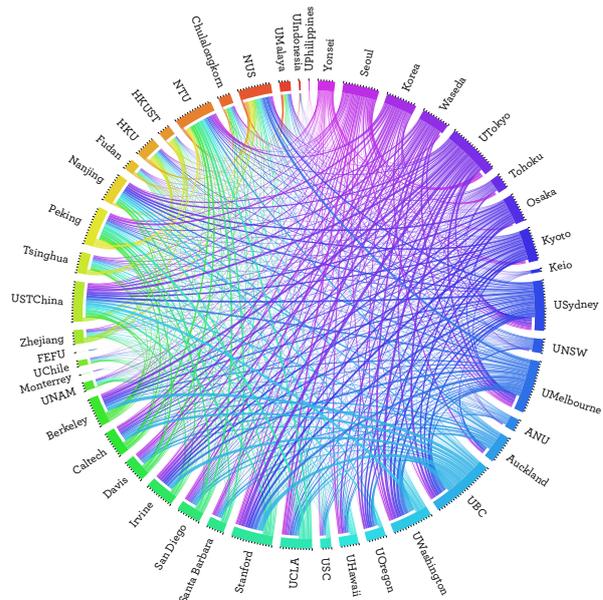


FIGURE 40: International APRU collaboration only - institutions are organised and coloured by geography, highlighting the international ‘connectors’. Data: SciVal [A]

Overall collaboration rates by institution

APRU institutions see higher than average rates of collaboration both with industry and internationally as previously described in Figure 15 (page 16). Within the group there is variation as shown in Figure 41. Local collaboration (defined here as collaboration with institutions within 50km) is dependent on the geographical location and clustering of academic institutions.³⁶ Universities in Tokyo, Seoul and Beijing appear particularly collaborative within their cities. All institutions have international collaboration above the global average of 17.4%. Some institutions are extremely connected internationally such as Auckland, UBC, NUS, ANU, University of Chile and Caltech with around 50% or more of publications produced with international authors.³⁷

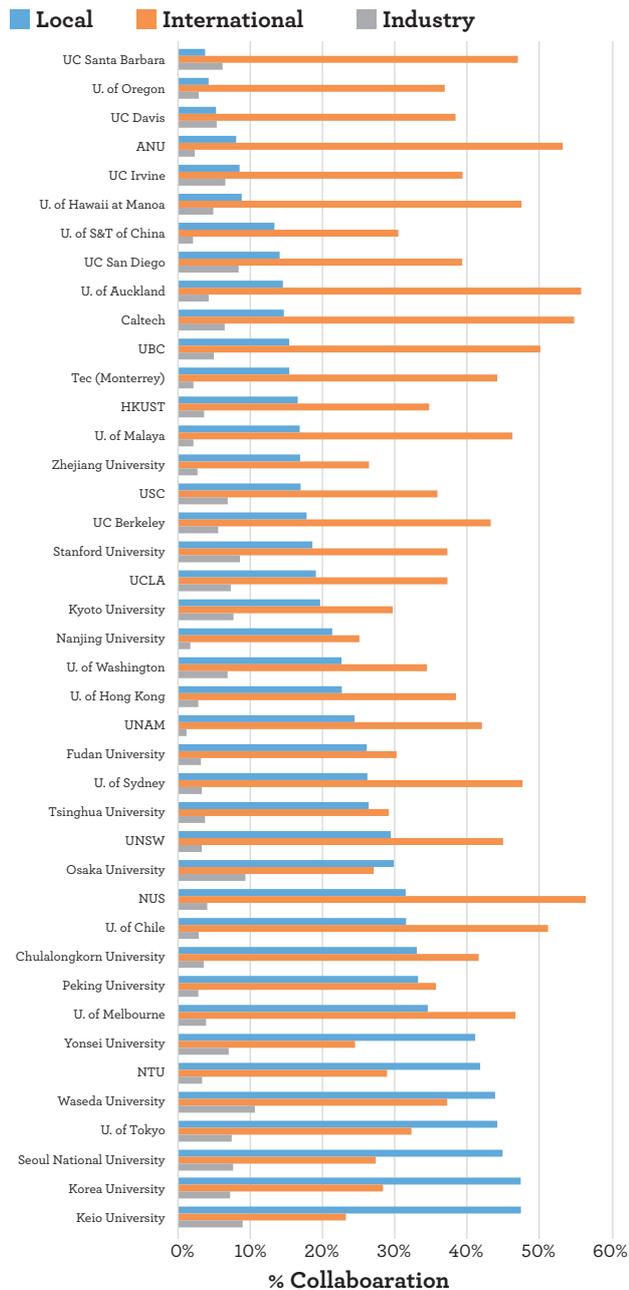


FIGURE 41: Local (<50km), international and industry collaboration rates across APRU institutions. Data: see Endnote 36

Cross-sector collaboration: 2006-2015

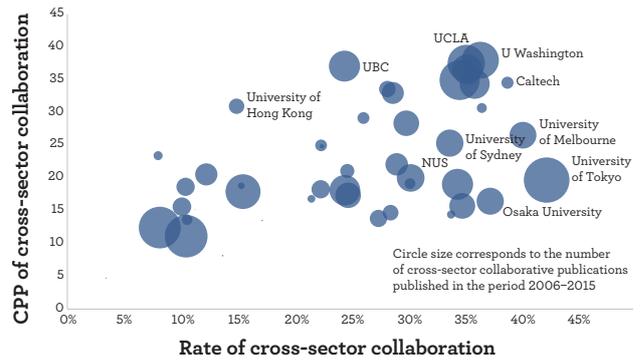


FIGURE 42: Cross-sector collaboration rates within APRU. Data: Elsevier [B]

5.2 Interdisciplinary collaboration

In today's world of complex questions and societal challenges, perspectives from many different disciplines are necessary. If an evidence base is to be used to inform decision-making, for example, it should take into account not only single factors such as economics but also a wide range of environmental factors, social impacts and indirect effects that may arise. The importance of this is highlighted further in Study 22.

Areas at the intersection between disciplines may also have often 'fallen between the gaps' historically, providing a rich ground for new discovery. They require collaborative engagement which may fall outside the comfort zone of many researchers.

STUDY 22 Interdisciplinary activities

Disaster Risk Reduction (DRR) through Integration and Interdisciplinary Work, University of Chile

CONTEXT: Chile has been affected by a series of disasters over the last decade – volcanic eruptions, earthquakes and tsunamis, floods and forest fires. Apart from the social and economic impacts, disasters have revealed large gaps in scientific knowledge, monitoring and alarm systems, and poor communication and coordination between scientists, government and communities. In addition, the focus has often been on disaster response rather than planning and mitigation.

COLLABORATION NEED: There are university researchers exploring aspects and types of disasters in virtually all faculties, from agronomy to forestry, seismology, mathematics and physical sciences, engineering, the social sciences and even law. Knowledge is fragmented and does not always have the multidisciplinary dimensions for dialogue with decision makers and stakeholders.

5.3

Summary

This study highlights both the academic research strengths of APRU, and the variety of areas both collectively and individually in which APRU institutions have a significant impact on society across the Pacific Rim. Through quantitative and qualitative data analysis this report finds APRU universities:

- exceed global and Asia-Pacific regional averages for performance in knowledge creation and research
- resource leadership in government, business and industry at high levels with their graduates
- exercise extensive social influence across their societies through their alumni
- project impact nationally and internationally through their roles as educators, connectors, societal problem-solvers, innovators, agents of change, and knowledge creators
- bring the strength of diversity to solving global challenges
- boost the quality of research output through international collaborations
- act as international connectors and as a knowledge resource on a range of international challenges from disaster science to population ageing, from global health and the future of the digital economy to sustainability and climate change

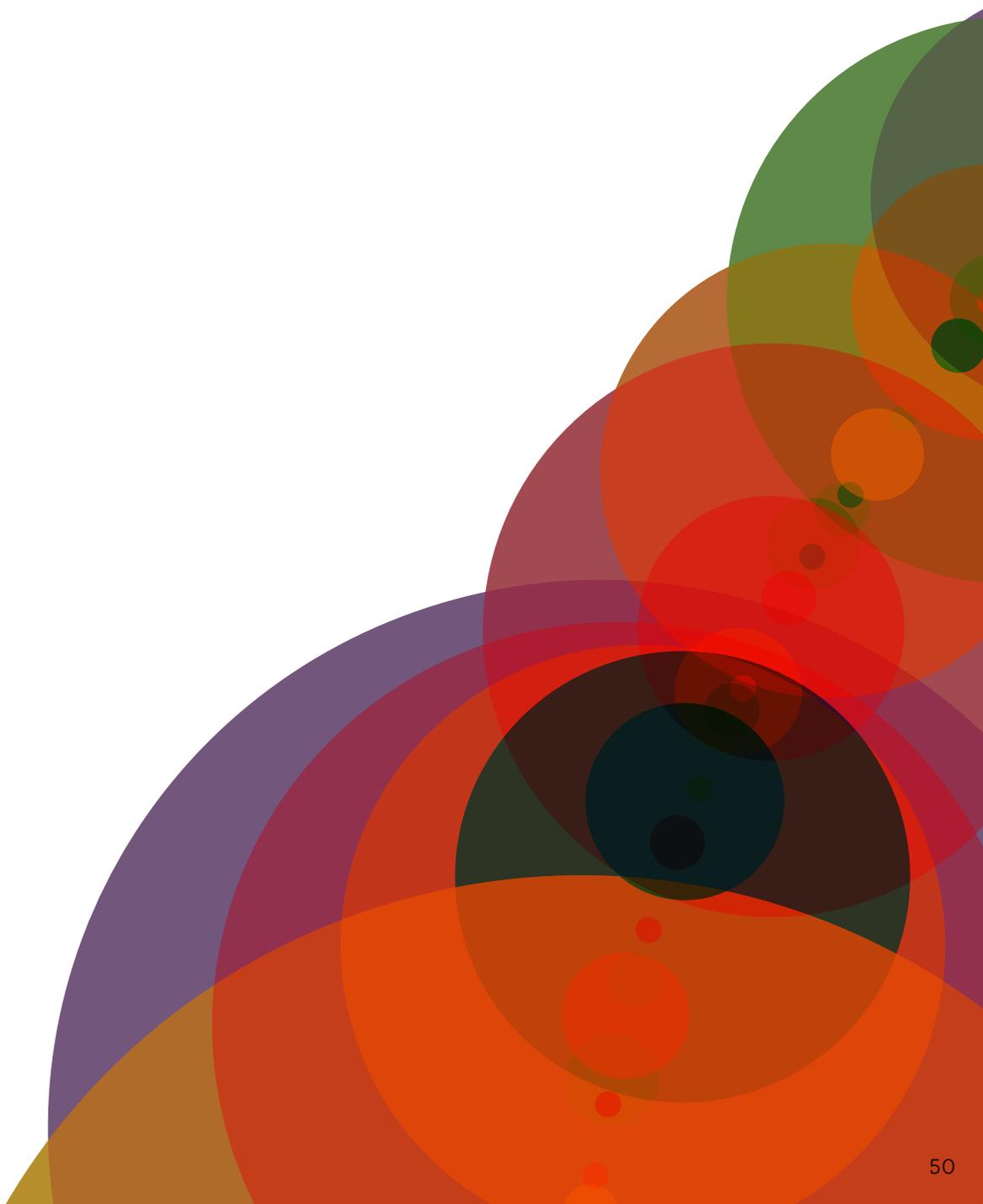
Research strengths and specialties of APRU as a collective include:

- Chemical engineering, materials science, physics and astronomy
- Neuroscience, biochemistry, genetics, molecular biology, immunology and microbiology
- Earth and planetary sciences

Evidence of interdisciplinary research is strong both in the bibliometric data in Chapter 5 and in the case studies presented, and key to delivering meaningful impact for society in topics such as disaster risk reduction where consideration of both technical characteristics and human behaviour are vital.

Case studies presented in Chapters 2 and 3 include areas where APRU institutions are already collaborating but also highlight institutional strengths and initiatives ripe for future collaboration. Case study topics provided were often chosen by senior management within each APRU institution and therefore provide some initial insight into priorities or areas of recent impact. Common themes of strength (besides disaster risk reduction) included: innovation in educational programs, health (notably infectious diseases) and environmental sustainability.

6. APPENDIX



6.1 Additional case studies

6.1.1

Educators

STUDY 23 Educators (Appendix)

Educating Global Health Citizens, National Taiwan University (NTU)

CONTEXT: As a strong member of APRU Global Health, NTU's College of Global Health's (NTU-CGH) key mission is to improve the health of populations worldwide by devotion to education, research and service.

NTU-CGH plans to achieve this vision through the development of well-rounded global students, advanced local and worldwide research collaboration, and continual participation in major global health events and organisations.

COLLABORATION: Initiatives include

- Increasing the mobility of students through exchange programs, for example recently receiving a student delegation from Kyoto University School of Public Health, paving the way to a long-term dual degree program.
- Offering training programs for physicians of health care agencies, administrators, public health nurses, and other public health workers (see Study 9 as an example application).
- Actively participating in the APRU Global Health Program, hosting the 2014 Global Health Workshop. NTU-CGH is also a member of the M8 Alliance of Academic Health Centres, Universities and National Academies.

6.1.2

Societal problem-solvers

STUDY 24 Societal problem-solvers (Appendix)

Sustainable Cities, University of Oregon (UO)

CONTEXT: UO, situated in one of the most pristine, undeveloped corners of the US, is at the cutting edge of research in sustainable development. Sustainability, environmental conservation, finding a way to produce jobs while protecting natural beauty and preserving natural resources for generations to come are essential to Oregon state and UO's social contribution as a premier research university.

INITIATIVE: UO is home to the Sustainable Cities Initiative, which directs a year's worth of student projects from 30 advanced seminars in architecture, urban planning, economics, law, product design, and other fields to help solve the urban sustainability challenges of a single client city. The city's government pays a six-figure fee for the analyses and research conducted by UO's students. The New York Times has described the Sustainable Cities Initiative as "perhaps the most comprehensive effort by a US university to infuse sustainability into its curricula and community outreach" while Forbes has noted that "the program takes city change on at an unprecedented scale." The Chronicle of Higher Education and the Financial Times have also praised the program. UO is a leader in research and teaching on green chemistry, the materials science behind alternative energy, environmental law, and sustainable business practices. In 2013 it launched the first transnational sustainable development research centre in Africa (one branch in Oregon, one in Gabon), funded with a US\$20 million endowment investment from the government of Gabon. This is all part of the UO commitment to and expertise in sustainable urbanism and regional development, now at the centre of APRU's newest research hub.

COLLABORATION: Sustainable Cities Initiative – see Section 2.3.2

6.1.3

Disaster risk reduction

STUDY 25 Disaster risk reduction (Appendix)

Leadership in Natural Hazard Research, University of Oregon (UO)

CONTEXT: UO is located between the Cascadia Subduction Zone and the volcanic Cascade Mountain Range and is part of the Pacific Rim 'Ring of Fire'. From volcanology and earthquake sciences, to environmental geoscience and studies of deep time, UO takes an integrated interdisciplinary approach to the study of natural hazards.

INITIATIVES: New Volcanology Center: UO is working to expand its volcanology research by creating a centre that will focus on volcanic processes and hazards, and geothermal energy. This includes using satellite and ground-based instruments for monitoring eruption processes and the transport of ash and gas in the atmosphere, and investigating the physics of volcanic plumes, pyroclastic flows and ash deposition, especially as it relates to human and aviation hazards.

INTEGRATED NATURAL HAZARD ANALYSIS TOOL: In addition, UO is partnering with the Earth Observatory of Singapore to build an integrated analysis and mapping tool to forecast natural hazards. A multidisciplinary approach to natural hazards will determine the relative contributions of different

natural processes to the overall hazard of an event. For example, earthquakes may be accompanied by surface rupture, ground motion, landslides, and flooding associated with tsunamis.

The societal consequences of these complex events vary tremendously depending on spatial details of the geologic setting and temporal variables like the time of year, weather, and tides. The project will permit full-range analysis of natural hazards and allow scientists to develop scenario-based forecasts. This could guide planning and preparation for post-disaster assistance for a particular region.

General Education for all Tertiary Students to Apply Interdisciplinary Approaches in Disaster Risk Management, University of the Philippines (UP)

INITIATIVE: D*MAPS: Disaster Risk Mitigation, Adaptation and Preparedness Strategies is a one-semester course in general education that has been recently offered by UP Diliman.

It is currently being redesigned to be adapted by other campuses of UP as well, especially in anticipation of the General Education Program reform in the university. D*MAPS uses original creative productions (e.g. short videos) by the student groups and other communication materials with appropriate scientific contexts that address specific audiences. Students from all majors are able to work in small groups, and instructors come from a range of departments and colleges including fine arts, art studies, psychology, education technology, and engineering. Risk management is emphasised over disaster management. "Hazards need not turn into disasters."



Development of Just-in-Time Training for Hazards Risk Reduction in Under-served Populations, University of Hawai'i at Mānoa (UHM)

CONTEXT: UHM's National Disaster Preparedness Training Center has been working to develop 'just-in-time' training for emergency managers and first responders on low probability, high-impact events, like tsunamis. The training provides critical information for disaster preparedness and response.

INITIATIVE: Scientific information and essential knowledge about hazards and threats for those involved in emergency response is provided through web-based delivery that can be accessed 'just-in-time', when needed. A YouTube video gives a clear explanation of what a tsunami is and how to respond.

This is part of UHM's online initiative to reach at-risk, vulnerable, under-served populations.

RESULTS: At the recent United Nations World Conference on Disaster Risk Reduction held in Sendai, Japan, the BBC recognised UHM's NDPTC for development of its 'just-in-time' tsunami training. The video presentation features one of the world's foremost tsunami experts, Dr Eddie Bernard (ret.), from the National Oceanic Atmospheric Administration's Pacific Marine Environmental Laboratory, who is also an NDPTC subject matter expert and instructor.

Implementation Science for Integrated Disaster Risk Management, Kyoto University

CONTEXT: Kyoto University established the Disaster Prevention Research Institute (DPRI) in 1951. Currently DPRI has about 100 researchers in five divisions and six centres, dealing with multi-hazards such as earthquakes and tsunamis, volcanic eruptions, landslides, flood, drought, etc. An integrated management approach is one of the keys to reducing the hazards of natural disasters.

COLLABORATION: Since 2001 DPRI has managed the Natural Disaster Research Council (NDRC), which is a research network for domestic institutions including about 900 individual researchers. Taskforce teams are formed for significant disasters using Grant-Aid for Scientific Research supported by the Japanese government.

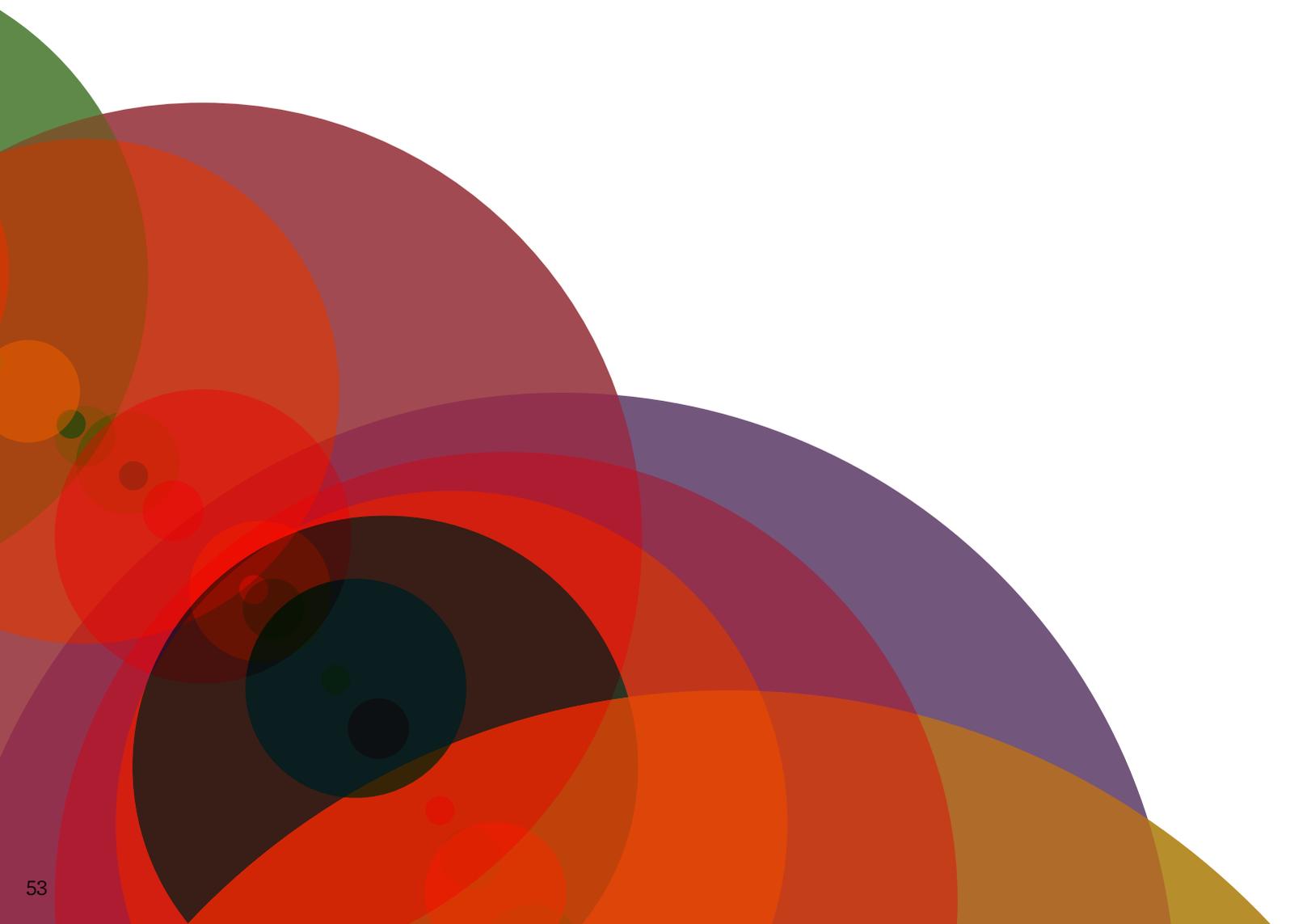
Immediately after the UN World Conference on Disaster Risk Reduction (WCDRR) in Sendai in March 2015, DPRI established the Global Alliance of Disaster Research Institutes (GADRI), comprising 88 organisations from 24 countries/regions.

Industry-university collaborative research is also undertaken for mutual benefit. A number of overseas researchers are invited as DPRI Visiting Professors to promote international cooperation projects.

EDUCATION: DPRI develops graduates to master's and doctoral levels and is involved in cross-disciplinary education and research in many other graduate schools, in fields ranging from engineering to earth sciences, and socio-economic and international disciplines. The DPRI provides national and local governmental disaster management policies and technologies. It also organises public/private forums and seminars, which are very important for contributing to preparedness of communities.

7.

DATA SOURCES AND REFERENCES



7.1

Key data sources

The following key data sources were gathered and analysed by Perspicuity Consulting Canada in the production of this report:

Education, research, science, innovation

- [A] Bibliometric data from SciVal®, a registered trademark of Reed Elsevier Properties S.A., used under license
- [B] Bibliometric data supplied directly by Elsevier from Scopus®
- [C] UNESCO Institute for Statistics Data Centre (UIS.Stat), Datasets: Science, Technology and Innovation, Education, Demographic and Socio-economic (<http://data.uis.unesco.org/>)
- [D] UNESCO Institute for Statistics, Dataset: Global flows of tertiary education students
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- [G] Education at a Glance 2011: OECD Indicators
- [H] OECD Science, Technology and Industry Scoreboard 2013
- [I] WIPO Statistics Database
- [J] World DataBank: World Development Indicators, Education Statistics, Global Bilateral Migration (<http://databank.worldbank.org/>)
- [K] National Center for Education Statistics (USA), Integrated Postsecondary Education Data System (IPEDS) data
- [L] Data from The Atlas of Economic Complexity, Center for International Development at Harvard University (<http://www.atlas.cid.harvard.edu>)
- [M] APRU institution Annual Reports and/or Strategic Plans (2014 or latest available year)
- [N] Nobel Prize winners (<http://www.nobelprize.org/>)
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Natural Hazards and Disaster management

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These sources were supplemented by personal communications and interviews with APRU institutions and the APRU Secretariat.

7.2

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7.3

Endnotes

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- 2 Analysis of data from World DataBank [J]
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- 4 Analysis of data from World DataBank [J]
- 5 http://www.apfed.net/pub/apfed1/final_report/pdf/overview.pdf
- 6 Analysis of country profiles [O]
- 7 OECD.Stat [F]
- 8 <http://education.nationalgeographic.org/encyclopedia/ring-fire/>
- 9 www.worldriskreport.org, 2014
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- 12 Analysis of UIS.Stat [C]
- 13 Analysis of UIS.Stat [C]
- 14 Analysis of UIS.Stat [C]
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Perspicuity Consulting is a specialist consultancy, focusing on understanding and developing pathways to impact of research on society. Through transparent analytics and contextual framing we provide an evidence-base to assist decision-makers as they prioritise use of resources and seek to accelerate realization of benefits.

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