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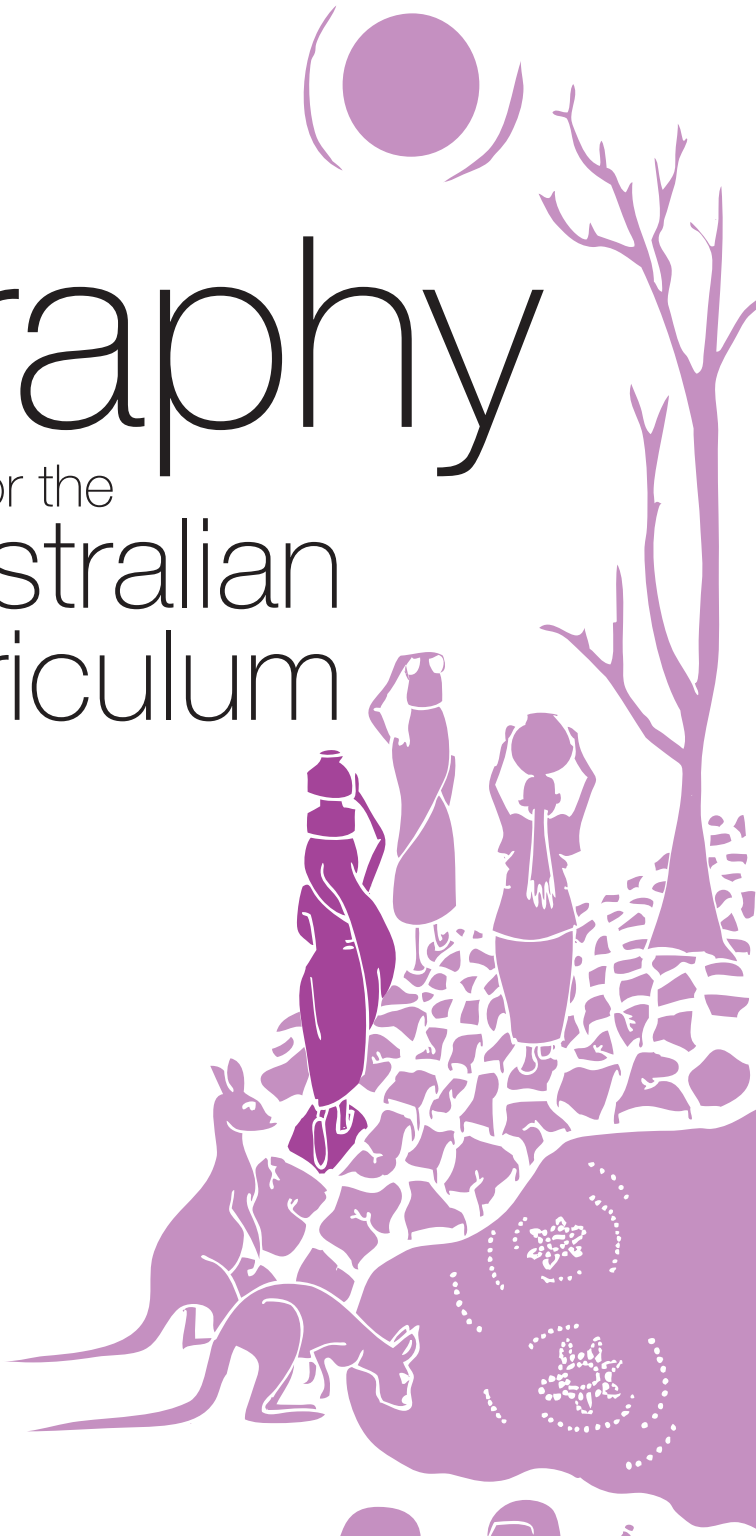

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ISBN 978-1-107-69012-7

Cambridge University Press

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477 Williamstown Road, Port Melbourne, VIC 3207, Australia

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www.cambridge.edu.au
Information on this title: www.cambridge.org/9781107690127

First published 2014

Cover designed by Sardine Design
Typeset by Kerry Cooke
Printed in Singapore by C.O.S Printers Pte Ltd

A Cataloguing-in-Publication entry is available from the catalogue of the National Library of Australia at www.nla.gov.au

ISBN 978-1-107-69012-7 Paperback

Additional resources for this publication at www.cambridge.edu.au/GO

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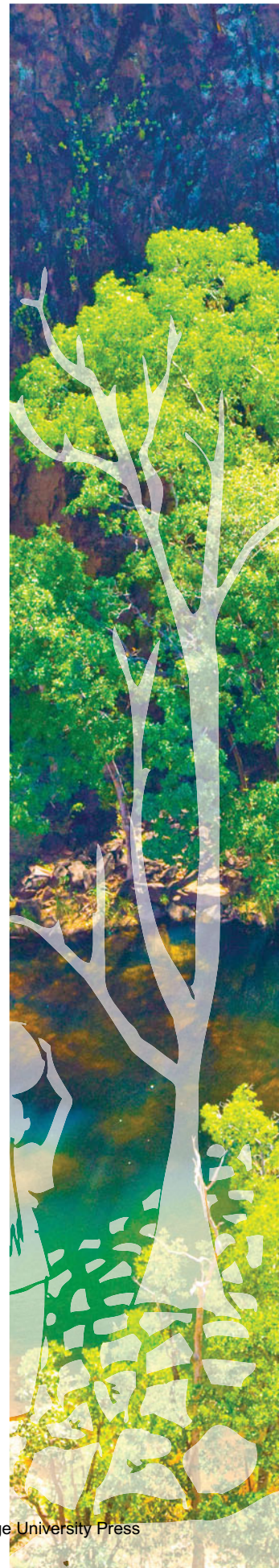

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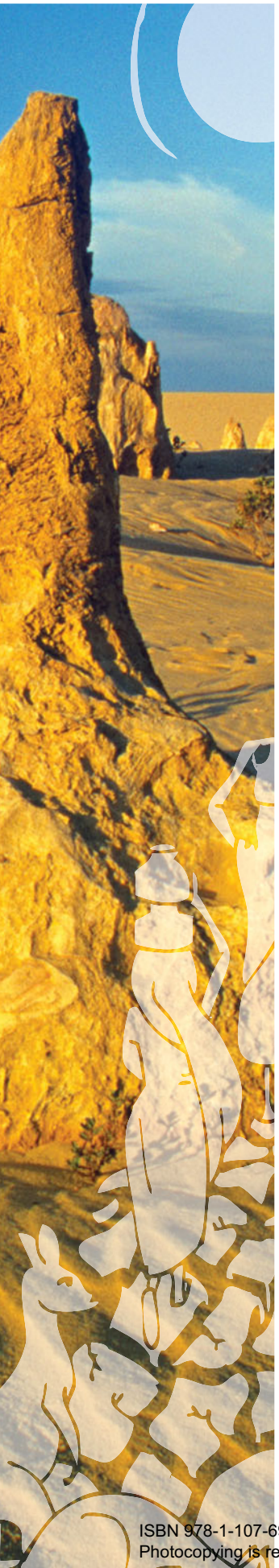

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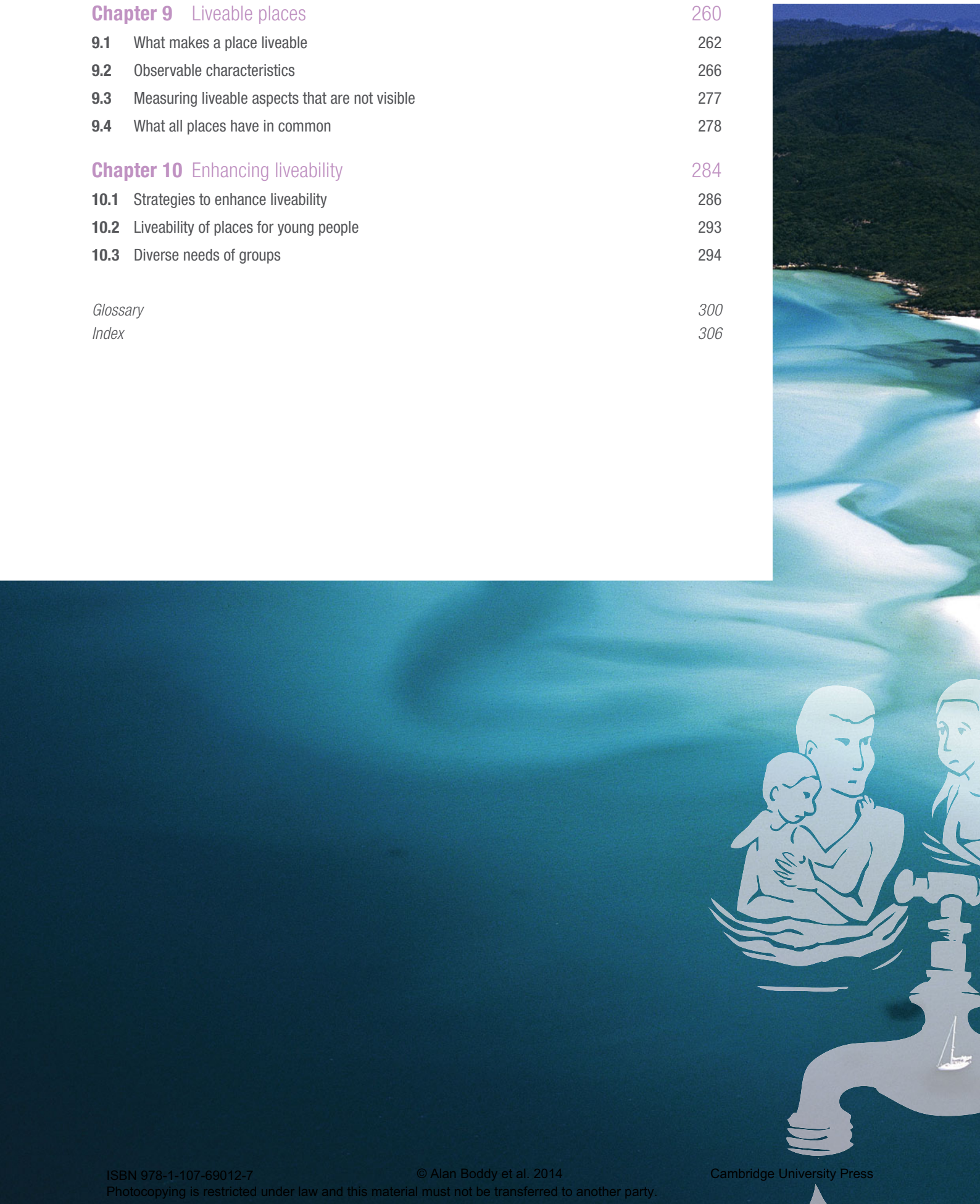

ISBN 978-1-107-69012-7

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Catherine Acworth is a senior coastal specialist within the Crown Lands division of the NSW Department of Primary Industries and has been working in the field of coastal management for over 5 years. In addition to working on the Tweed River Entrance Sand Bypassing Project, Catherine has managed significant storm surge and coastal inundation projects for the Queensland Government Coastal Impacts Unit, in particular the Gulf of Carpentaria Storm Tide and Inundation Study. She has an Honours degree in Marine Science from the University of Sydney and a Masters in Coastal Engineering and Management from the University of New South Wales. She has travelled extensively in developing nations and her personal research involves using film and photography to document the effects of climate change and climate change adaptation strategies in coastal communities.

Alan Boddy teaches at Bendigo Senior Secondary College and lectures in Geography Method at La Trobe University, Bendigo campus. Alan has been involved in Geography education for 32 years. He has taught Geography for 9 years at the 7–10 level and over 20 years at the senior level. He was Head of Department in Humanities at Bendigo Senior Secondary College and a lecturer at La Trobe University's Outdoor Education and Environment Centre for several years. He was Education Officer at Melbourne Zoo, the Central Deborah Gold Mine and the Discovery Science and Technology Centre for the City of Greater Bendigo. He has also contributed to the recent publication *The travellers' guide to the goldfields*.

Tamara Boyer has been teaching Geography, Studies of Society and Environment and Religious Education to high school students in the Catholic sector. Tamara has been the Head of Society & Environment at Aranmore Catholic College for the past 9 years. She graduated from Curtin University in Perth, Western Australia with a Bachelor of Education (Secondary) at the end of 1996. Her passion for geography led to her involvement as a Councillor for the Geographical Association of Western Australia. She was appointed as an adviser and writer for Geography curricula at both state and national levels and contracted to write resources and exams and provide professional development for Geography teachers. In 2008, she published her first textbook (*Sustainable planet: resource geography for senior school students*). She has also written online resources for the Australian Geography Teachers Association and it is her goal to get as many young people to love geography just as much as she does.

David Butler is the chief writer for Reconciliation South Australia in the development of the Foundation to Middle Years Reconciliation Education packs. David is an executive member of the Australian Association for Environmental Education (AAEE) and is coordinator of the AAEE Teacher and Teacher Education Special Interest Group (TTE SIG). He has over 30 years' experience in working with and writing Geography curriculum and teaching and learning guidelines through his involvement with South Australian state geography committees and the Geography Teachers' Association of South Australia (GTASA). He is former President of the Australian Geography Teachers Association (AGTA) and the GTASA, and is a life member of GTASA. He was also Manager of the Society and Environment curriculum in the South Australian Education Department and an Australian Curriculum: Geography Advisory Panel member for the Australian Curriculum, Assessment and Reporting Authority (ACARA).

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Matthew Davidson has been head Geography teacher at Waverley Christian College in Wantirna South, Victoria, for the past 8 years. Matthew has presented sessions at various conferences and events, including the annual Geography Teachers Association of Victoria (GTAV) conference, Victorian Certificate of Education (VCE) conferences and Christian Schools Australia (CSA) conferences as well as Geography student exam revision lectures. He has also been a year level coordinator for a number of years and is currently a member of the GTAV Committee. He is an innovative Geography teacher who is passionate about developing curriculum that is relevant and engaging.

Cheryl Desha has a degree in Engineering (Environmental, first class) and a PhD in rapid curriculum renewal. Her research for the last decade has focused on building capacity for sustainable development within tertiary education, including outreach and bridging with secondary schools, managing the development of high school resources on a range of sustainability topics in collaboration with the Australian Sustainable Living Challenge (UNSW, Griffith University). She is a Senior Lecturer in the School of Earth, Environment and Biological Science (Science and Engineering Faculty) at the Queensland University of Technology (Brisbane, Queensland), and a Principal Researcher with The Natural Edge Project (TNEP), a sustainability think-tank which operates as a collaborative partnership for research, education and policy development on innovation for sustainable development.

Deirdre Dragovich is an associate professor in the School of Geosciences, University of Sydney and has taught both undergraduate and postgraduate geography and geomorphology. Deirdre currently supervises four PhD students and is responsible for teaching two postgraduate units in environmental science. She is co-author of *The Australian physical environment* (2008) and co-editor of the earlier Meridian series of first year university Geography texts. Previously she contributed to curriculum discussions in Geography at matriculation level, wrote materials for high school teachers, and was involved in 'Geography Update' days. As Associate Dean in the Faculty of Science, she was instrumental in establishing 10 postgraduate degrees, several involving inter-faculty contributions from Electrical Engineering, Economics, Agriculture, Veterinary Science, Architecture and Arts. She was awarded the Macdonald Holmes medal for contributions to geographical education by the Geographical Society of NSW and was a member of the advisory committee for the national Geography curriculum.

Tony Eggleton is an emeritus professor of the Australian National University. Tony graduated with first class Honours in Science from the University of Adelaide, then completed the degree of Doctor of Philosophy at the University of Wisconsin, USA. For his extensive research into mineralogy he was awarded the degree of Doctor of Science by the University of Adelaide in 1999.

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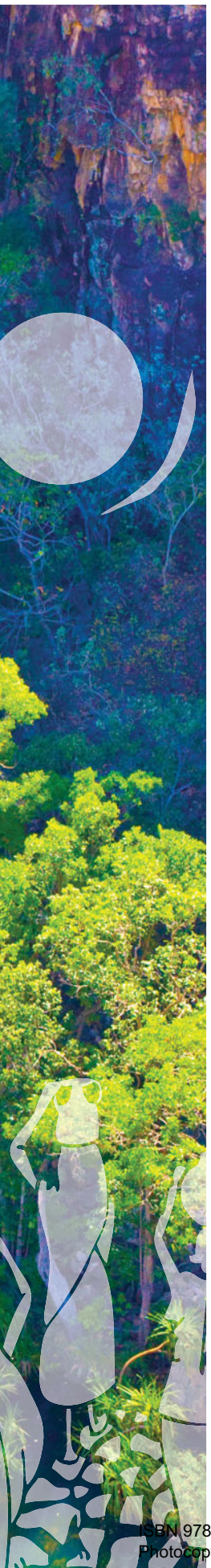

research interests are in the areas of demography, economic development, energy efficiency and sustainability studies with a focus on China. She is currently conducting research for the Australian Research Council on energy efficiency, economic growth and the environment in China.

Karlson 'Charlie' Hargroves, after graduating from the University of Adelaide in 2000 and spending 2 years as a practising civil/structural design engineer, co-founded 'The Natural Edge Project' (TNEP), an internationally recognised team of early career academics across various universities including Curtin University, Adelaide University, QUT, Griffith University and ANU. He has led the TNEP team to deliver four international books on sustainable development (selling over 80 000 copies in four languages) in collaboration with some of the world's leaders in sustainability, such as Gro Brundtland, Ernst von Weisacker, Amory Lovins, Rajendra Pachauri and Peter Newman. The first book won the Australian Banksia Award for Environmental Leadership, Education and Training in 2005, and the two most recent books were ranked among the 'Top 40 Sustainability Books' in the world in 2010 by the Cambridge Sustainability Leaders Program. He joined the Curtin University Sustainability Policy (CUSP) team in 2010 and works on a series of projects focused on the sustainable built environment, in collaboration with the Sustainable Built Environment National Research Centre and the Cooperative Research Centre (CRC) for Low Carbon Living.

Grace Larobina is the HSIE faculty geography subject facilitator at The Hills Grammar School in New South Wales. Grace has taught years 7–8 History, years 7–12 Geography and years 11–12 Legal Studies over her 25-year teaching career. She has had experience in girls' education and coeducation at various NSW schools including Cerdon College and Mary MacKillop College. She completed her teacher training at the Catholic College of Education Sydney, where she graduated with her Diploma of Teaching, and at the South Australian College of Advanced Education, where she graduated with a Bachelor of Education. She has been employed by the Board of Studies for Geography School Certificate Marker and Higher School Certificate (2005), served on the Board of Studies Geography Reference Group (2012), served as the independent sector representative for the ACARA Mapping the Australian Curriculum Draft F–10 (2012) and is accredited by both the Independent Schools Teacher Accreditation Authority (ISTAA) at Classroom/Professional Excellence level (2007) as well as through the NSW Institute of Teachers to the level of Professional Accomplishment (2011). She has also served as a council member on the Geography Teachers' Association of NSW since 2010. She has travelled extensively in Europe, the USA, the Pacific Islands and Canada with an intense interest in the geography and history of societies.

David Lergessner is a lecturer in Geography in the Faculty of Education, School of Cultural and Language Studies at the Queensland University of Technology (QUT). David has written extensively on the Geography curriculum and pedagogy, and wrote the 'People and environment' series (1989–92) as well as *Geomorphology* (1995). He was a high school Geography head of department for 35 years before retiring and joining QUT. He has held almost all positions in the Geography Teachers' Association of Queensland (GTAQ) except treasurer and for many years was the journal editor and conference convenor. He is a regular presenter at GTAQ and Australian Geography Teachers Association (AGTA) conferences on topics to do with physical geography, with his study of environmental hazards taking him to many places around the world including Mount St Helens, Greenland, New Zealand, Vanuatu and Antarctica.

Dora Marinova is a professor of sustainability and deputy director of the Curtin University Sustainability Policy (CUSP) Institute in Perth, Western Australia. Dora's current research relates

ISBN 978-1-107-69012-7

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Simon Miller is currently head of Geography at Pembroke School in Adelaide. He has been a specialist Geography teacher for 10 years, working in both the United Kingdom and Australia. Simon is the vice-president of the Geography Teachers' Association of South Australia, where he has served on the executive committee for 6 years. He has co-authored a workbook for the BBC Bitesize series in the United Kingdom, where he has also contributed to the Geography Association's *Geography teacher's handbook*.

Peter Newman is the professor of sustainability at Curtin University and the director of the Curtin University Sustainability Policy Institute. Peter is a lead author for transport for the UN's Intergovernmental Panel on Climate Change (IPCC). He is on the board of Infrastructure Australia, which is funding infrastructure for the long-term sustainability of Australian cities. He has written 15 books, including his book with Jeff Kenworthy, *Sustainability and cities: overcoming automobile dependence*, which was launched in the White House in 1999. In 2001–03 he directed the production of Western Australia's Sustainability Strategy in the Department of the Premier and Cabinet. It was the first state sustainability strategy in the world. In 2004–05 he was a sustainability commissioner in Sydney, advising the government on planning issues. In Perth, he is best known for his work in saving, reviving and extending the city's rail system. He invented the term 'automobile dependence' to describe how we have created cities where we have to drive everywhere. For 30 years since he attended Stanford University during the first oil crisis, he has been warning cities about preparing for peak oil. In 2011 he was awarded the Sydney Luker medal for his contribution to the science and practice of town planning. From 1976 to 1980 he was a councillor in the City of Fremantle where he still lives.

Nonja Peters is the director of the History of Migration Experiences (HOME) Centre at Curtin University. Nonja is an historian, anthropologist, museum curator and social researcher with a special interest in the preservation of immigrants' cultural heritage, in particular Dutch maritime, military, migration and mercantile connections with Australia since 1606; the migration experience; and immigrant entrepreneurship. She is currently involved in academic and community-based research in all these fields. She sits on the board of the National Library of Australia, the Maritime Museum Advisory Committee, the National Archives Advisory Committee and Associated Netherlands Societies of Western Australia. She has been awarded the Centenary Medal and a Dutch Knighthood for the preservation of immigrants' cultural heritage. She has also published widely on issues relating to migration and her book *Milk and honey – but no gold: postwar migration to Western Australia 1945–1964*, was short-listed for the Western Australian Premier's 2001 Literary Award, the Queensland Premier's 2002 Literary Award for History and the New South Wales State Records John and Patricia Ward History Prize. She was formerly the director of the Migration, Ethnicity, Refugees & Citizenship Research Unit.

Ken Purnell is editor of *Geographical Education* and on several other journal boards. Ken is also an associate professor at Central Queensland University (CQUniversity) Australia where he teaches Geographical Education as well as holding various academic leadership roles (see www.kp.cqu.edu.au). He has been involved with boards of studies over the years and since 2005

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represents higher education on the Queensland Studies Authority Curriculum Committee, having been on the governing board. He has a real interest in building students' love of Geography as a way of seeing and experiencing their world.

Angela Reeve has a degree in Engineering (Environmental, first class) and is currently completing her PhD in policy pathways and mechanisms for change towards biophilic urbanism. Over the last 5 years, her research has been focused on fostering behaviour change for energy efficiency, rapid curriculum renewal for engineering programs in Australia to integrate more energy efficiency content into courses, and informing sustainability policies for regional plans. Angela is a PhD candidate at the Queensland University of Technology, and a researcher with the Natural Edge Project (TNEP), a sustainability think-tank which operates as a collaborative partnership for research, education and policy development on innovation for sustainable development.

Margaret Robertson is professor of Education at La Trobe University. Margaret is a former research director for the faculty and currently holds the position of Deputy Chair of the Australian Academy of Science's National Committee for Geography. Her long association with the International Geographical Union has included serving an 8-year period as executive secretary for the Geographical Education Commission. Her research and publication interests focus on cultural geography, particularly young people's geographies and applications of social media and digital technologies. She has been recognised for her contributions to education with a fellowship of the Australian College of Educators.

Heather Ruckert teaches Geography and part of the Careers Consultancy team at Tintern Schools in Melbourne. Heather has a diverse background with tertiary studies in Geography, Economics, Information and Communications Technology, Management and Career Development. She is a highly experienced teacher with curriculum writing expertise across all secondary levels, including the International Baccalaureate, and her career spans over 20 years in the independent schools sector. Her roles as a former head of Geography and pastoral leader have shaped her holistic approach to student learning with her passion for geographic inquiry in the field.

Jesmond Sammut is an associate professor in Physical Geography, Faculty of Science at the University of New South Wales. Jesmond is also an adjunct professor and visiting professor at Gadjah Mada University and Hasanuddin University respectively. He conducts multidisciplinary research involving studies on soil and water processes, groundwater chemistry, river processes, causes of fish kills and fish disease outbreaks, the environmental impacts of development and sustainable development of coastal and inland resources. His current research involves improving food and income security in developing countries. He manages research and capacity-building programs in Indonesia, Vietnam and Papua New Guinea and has also worked in India, Thailand and the Philippines to apply geographical skills to environmental and aquaculture production problems. He teaches Environmental Impact Assessment (EIA) and Coastal Resource Management to undergraduate and postgraduate students in Australia and Indonesia, and also coordinates research and technical capacity building programs in developing nations. He is also the PNG Fisheries Consultant for the Australian Centre for International Agricultural Research (ACIAR) and an editor of the *Indonesian aquaculture journal*.

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Kate Thompson is the head teacher of Teaching and Learning at Chatswood High School and lecturer to post-graduate students studying Master of Teaching/Education at the Australian Catholic University. Kate was awarded the New South Wales Premier's Teacher Scholarship for Business Studies in addition to an Outstanding Professional Service Award issued by the New South Wales Minister for Education. She holds a Bachelor of Economics (Social Sciences), Master of Teaching, Master of Industrial Relations and Human Resource Management and a Certificate in Gifted and Talented Education. She has worked in curriculum development and support roles, developed HSC exams at the New South Wales Board of Studies and is passionate about engaging students and improving literacy. She is currently president of the Society and Culture Teachers Association and has co-written a widely used textbook for years 11 and 12 students. She is a regular presenter at professional development and student revision lecture days and has written a range of teaching materials published in the journal *Culturescope*.

Fiona Tonizzo is the VCAL and VCE educational leader at Pakenham Secondary College. Since beginning her teaching career, Fiona has been involved in curriculum development. She is passionate about teaching Geography and has taught at Patterson River Secondary College, where she was the head of Humanities. She counts being a foundation staff member at Kambrya College (formerly known as Berwick South Secondary College) as one of her most satisfying roles: she was a member of the team that began the school and oversaw the first few years of VCE at the college. She has always believed in maintaining professional ties to fellow educators, including the Geography Teachers' Association of Victoria (GTAV). She has presented many workshops through the GTAV at annual conferences, as well as at specialty conferences such as 'Thinking skills in the Geography curriculum and VCE'. She is currently the network leader for the Berwick group of the GTAV.

Andrew Walker teaches Geography, History and English at Parade College in Bundoora. Andrew is also a teacher of Outdoor Education and has a hands-on approach to Geography. He takes every opportunity he can to get his students out into the field with a map, a compass and a GPS.

Michelle Walker has a degree in Environmental Science with First class honours. She has worked on water planning and water conservation projects, with a focus on behaviour change, in remote central Australia and Townsville, and she is a Research Fellow with The Natural Edge Project (TNEP). Michelle has spent time volunteering with the Swatcha Ganga Abhiyan (Clean Ganges Campaign) in India, where she lived in the city of Varanasi and worked to build youth environmental leadership skills. Currently Michelle is undertaking a PhD, conducting research into the value of Indigenous knowledge in protecting freshwater resources in the Kimberley region, WA.

ISBN 978-1-107-69012-7

Acknowledgements

On behalf of the author team, the Publisher (Thuong Du) wishes to acknowledge the support of families, friends and the following staff at Cambridge University Press who worked tirelessly towards the publication of this textbook: Erin Clark (Permissions Controller), Margie Dela Cruz (Education Commissioning Editor), Jess Fitzgerald (Permissions Researcher), Courtney Frederiksen (Cover Art Illustrator), Linda Kowarzik (Education Publishing Director), Liam McManus (Education Commissioning Editor), Patrick O'Duffy (Education Senior Commissioning Editor), Rachael Pictor (Education Development Editor), Hanako Smith (Senior Production Controller) and Carolyn Wadey-Barron (Senior Project Editor).

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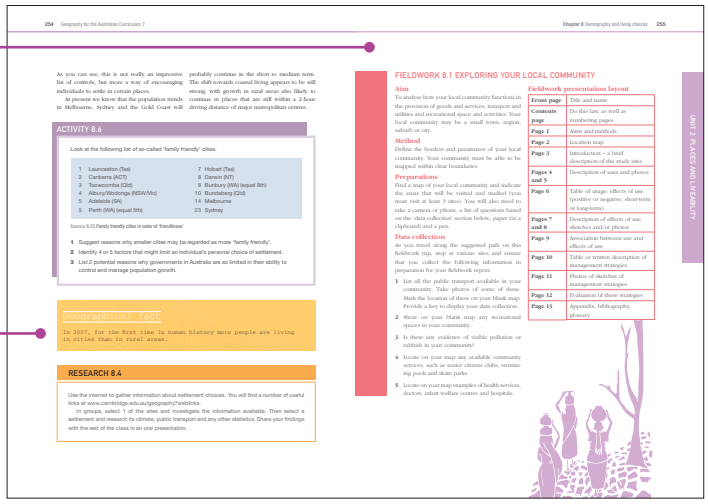
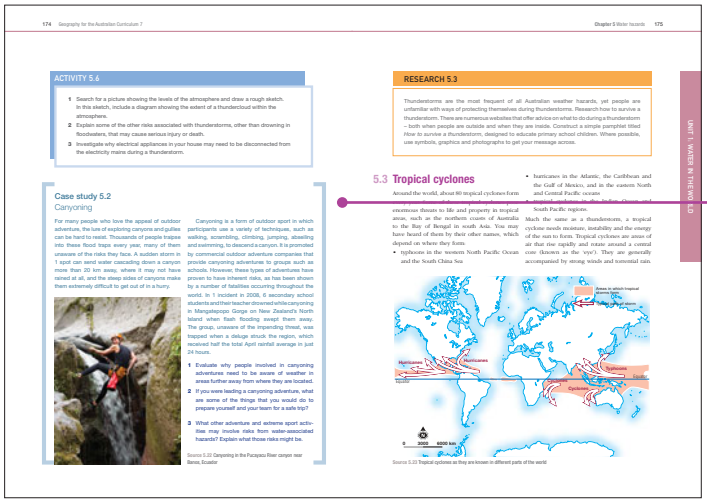
How to use this textbook

Chapter openers feature **Before you start** and **Let's begin** sections which focus your attention on the topics being studied and prepare you for your in-depth investigations.

Fieldwork activities provide step-by-step instructions on observing and recording information, enabling you to think like a geographer and utilise geographical skills outside the classroom.

Geographical facts highlight interesting information to enrich your learning.





Case studies extend on information to add another layer to your knowledge and understanding.

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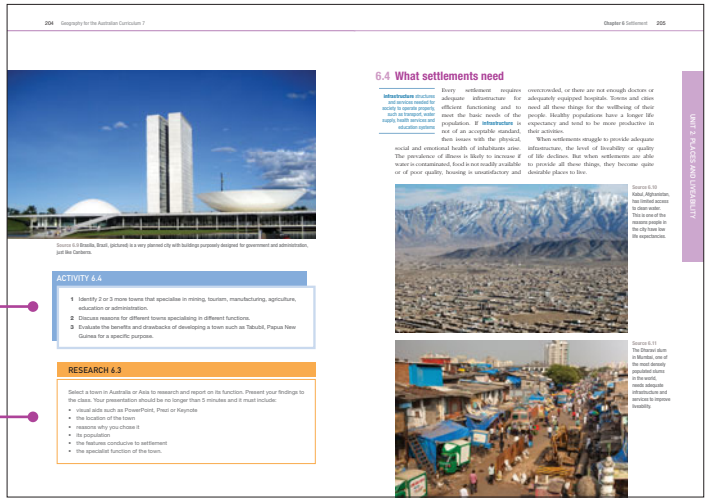
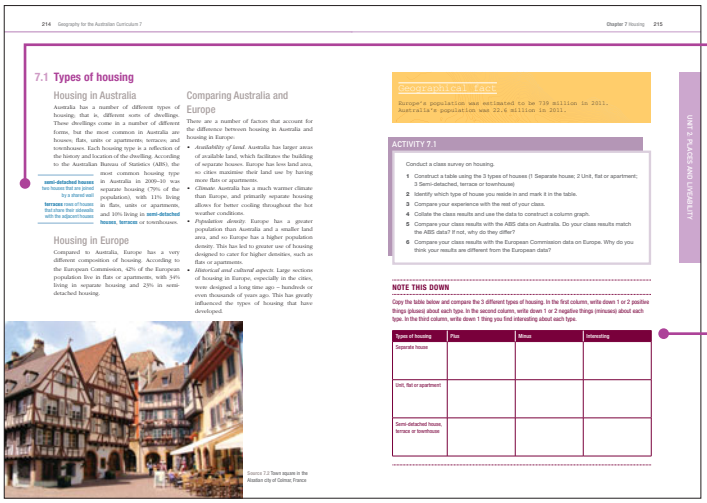
A variety of **activities** and **research tasks** explore key concepts, develop skills and draw back to the general learning capabilities and cross-curriculum priorities.



Glossary terms are bolded in the text, defined in the margins and collated at the end of the textbook for easy reference.



Note this down sections recommend the use of a range of graphic organisers to help you record and revise key ideas.

Chapter summaries review the main ideas of the topic to consolidate what you have learned.

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Geographical skills toolkit

0.1 Introduction

geography the scientific study of the Earth's surface (and immediately below it), especially the patterns and processes that affect it, such as climate, population, land use and environmental elements

Geography is the study of the Earth, especially the surface of the Earth: how it works and how humans interact with it. Geography involves describing, analysing and evaluating in order to understand and even predict how the elements that make up our world operate. It also includes the many ways that people can affect and use their environments, from the individual or family unit to the impact of larger groups, companies and even governments. How we live on the Earth and how we change the environment today influence what the planet will be like in the future. This geographical skills toolkit explains the skills and concepts used in the study of geography. These tools will help you to think like a geographer as you explore water as a renewable environmental resource and the concept of place through liveability.

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Source 0.1 The largest coral reef system on Earth is the Great Barrier Reef in Queensland, listed as a World Heritage site for its aesthetic and cultural value.

0.2 Geographical inquiry and skills

What sets the geographer apart from others interested in the world is often the methods we use to investigate. A geographer will collect data in the field and then develop a series of **hypotheses** to test their own work and investigation methods.

hypothesis a proposition made on the basis of limited evidence, used as the starting point for further investigation

Geographers enjoy working together in teams to share and discuss ideas. They know that the world is their laboratory and that inquiry-based research is highly effective. As a geography student, you will be using the methods of the professional geographer, although on a smaller scale. You follow an inquiry approach by working through a set of skills that represent a complete investigation:

- observing, questioning and planning
- collecting, recording, evaluating and representing

Source 0.2 Geographers are involved in highly specialised work that helps us to live sustainably on the planet, minimising negative impacts and supporting biodiversity in the environment as well as improving the lifestyles of people around the globe.

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- interpreting, analysing and concluding
- communicating
- reflecting and responding
- fieldwork.

Depending on the type of inquiry, you may only need to focus on a particular skill. Your work becomes part of the complex web of data collected and analysed to ensure that our global footprint rests lightly on the planet, allowing environmentally sustainable and responsible human activities.

Observing, questioning and planning

Geography is a scientific study and uses the same methods as other branches of science. The geographer begins planning an inquiry by observing issues or problems and developing geographically significant questions.

Developing geographically significant questions

Geographically significant questions are questions that are worth investigating. The inquiry questions at the beginning of each chapter form a model for geographical study, demonstrating the method used to construct a framework of questioning and learning. They prepare you for the learning to come and allow you time and readiness for the material ahead. They are not intended to limit your learning so that at the end of the chapter you are only able to respond to them; rather they are a scaffold that supports you to build your learning a level at a time, adding your own inquiry questions as appropriate. These questions become the language of our study, moving us beyond the known and into discussions and debates where there may be no right or wrong answer, just many options and challenges to be explored in order to build on our understanding of the world around us.

Inquiry questions

- Can water always be classified as a renewable resource?
- How does the movement of water through the environment connect places, and what are the implications of these linkages?
- How can Aboriginal and Torres Strait Islander people's knowledge about use and management of water contribute to the sustainability of water resources in Australia today?

Source 0.3 Examining the questions from Chapter 1 'Water: a renewable environmental resource', it is clear in what direction the study will develop.

Collecting, recording, evaluating and representing

How do we collect and record information? How do we evaluate and represent this information? The geographer uses a range of tools to gather information and needs to be aware of where information comes from in order to use it effectively.

Primary and secondary sources

Information gathered in the field that is directly connected to our research is called a **primary source**. A primary source is one that has yet to be analysed – for example, measurements taken from an experiment. Primary sources are essential to valid

primary source information that comes directly from the event or area we are studying. It is 'first hand' and we use it to classify most of the data collected during fieldwork

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scientific inquiry and are targeted and specific to the task. We understand how it has been collected, the methodology used in the process and if there were any elements that may have given unexpected results.

Information collected by others – perhaps people not directly involved in our research – is called a **secondary source**. Secondary sources can be valuable and even reduce the work we need to do directly. For example, the Australian Bureau of Statistics (www.cambridge.edu.au/geography7weblinks) conducts the Census every 4 years, collecting demographic (population) information for the country. The Census asks questions such as: Where do people live? How far do they travel each day to work or school and what transport do they use regularly? This is information that would be difficult for us to collect on our own on such a large scale, but can be very useful.

secondary source information that is put together by someone not directly involved in the event or area that we are investigating

When collecting information, we need to be aware of ethical protocols including confidentiality, **informed consent**, **citation** and integrity of data.

informed consent permission granted in full knowledge of what is being asked and all consequences

citation full and appropriate referencing of a source

NOTE THIS DOWN

Copy the graphic organiser below and summarise what you have learned about primary and secondary sources.

Sources	Definition	Examples
Primary		Field notes
Secondary		Census data

Evaluating for reliability and usefulness

It is important that we can trust the data we use in our research. We need to know that the way it was collected has been appropriate and consistent. It is important that the way our data are gathered is reliable, but also that we are aware of any **bias** in the collection of the information that may make us review its value. If we are interviewing people in a town about using the local river's water, we need to know if they are relying on the water to irrigate their farm, if they like to fish in the river or if they are interested in creating paintings of the river to show the natural environment. Knowing this allows us to evaluate whether we can trust the information and how useful it will be in our work.

bias mindset with a particular interest or view that limits one's ability to make a fair judgement

Representing data

Once we have collected our data, we need to present them in the most appropriate form. Some information easily fits into a written discussion, while numerical or quantitative data may work better in a visual representation such as a graph or diagram. Other data work well in an annotated photograph, a sketch or even a map. Geographers not only analyse the data they have, but view them critically to decide what the best format for sharing that information will be.

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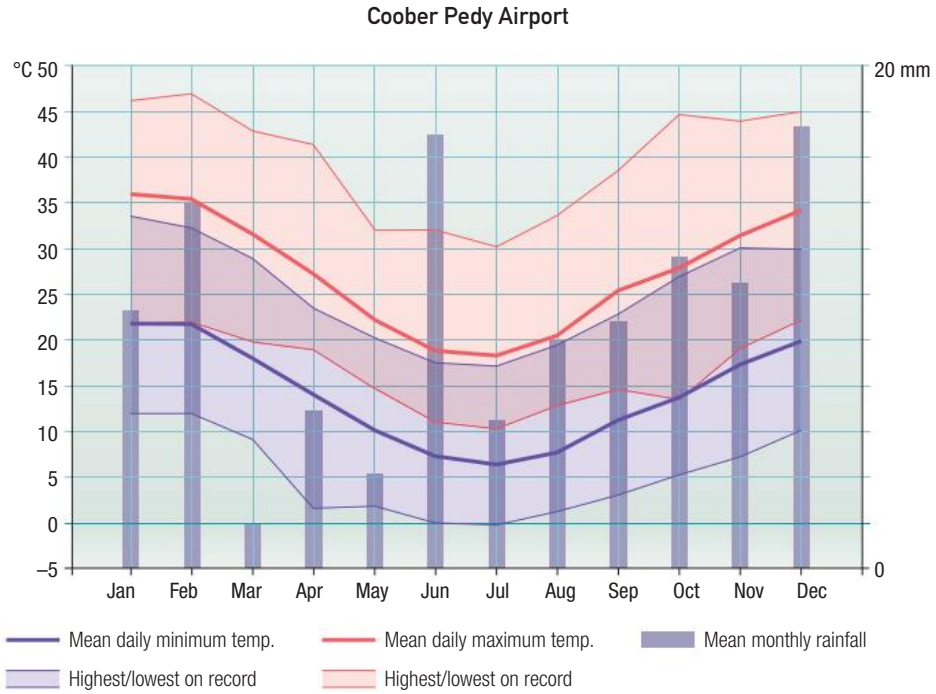
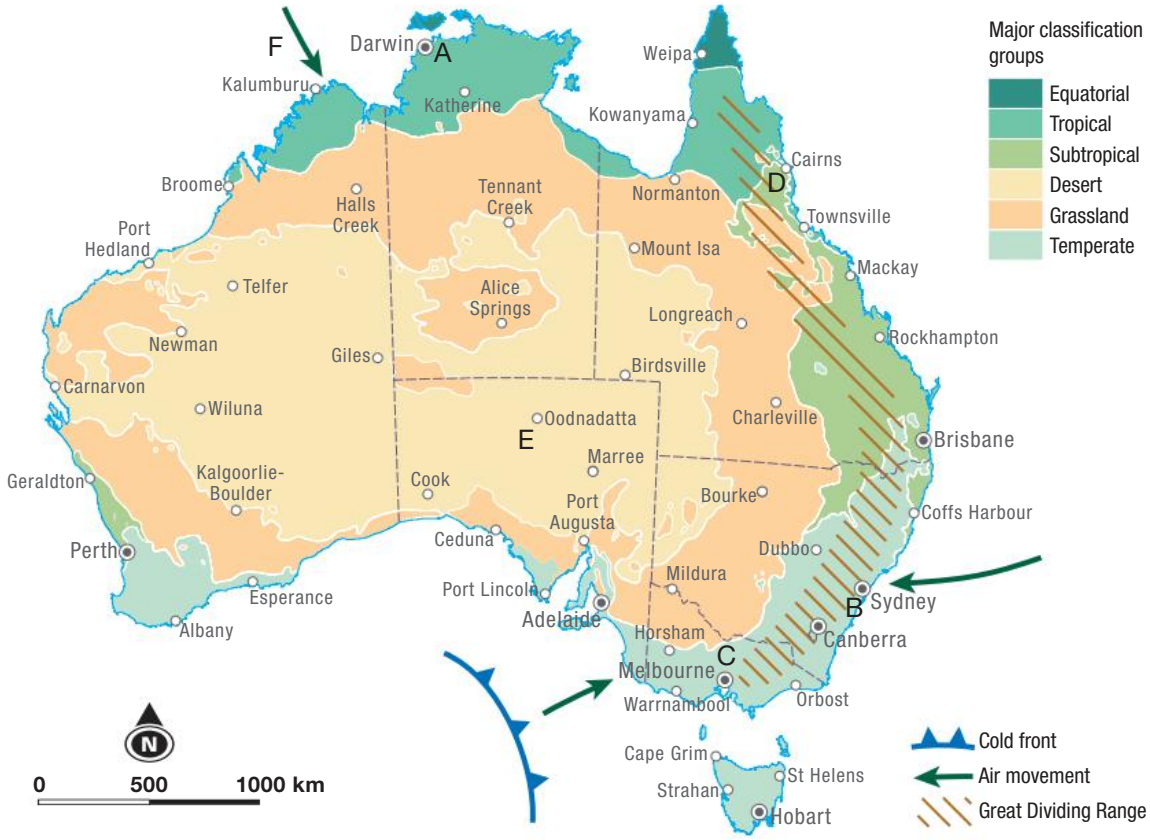


Source 0.4 Data can be represented in a range of appropriate forms including climate graphs, compound column graphs, population pyramids, tables, field sketches and annotated diagrams.



Source 0.5 Maps are probably the best-known geographic tool.

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Constructing maps

The same river can be viewed on a series of maps with information adding to our understanding of the system. We can see how steep the river valley is, the direction the river flows and the type of landscape it flows through. All of this information allows us to predict the impact of changes to the river if the surrounding environment changes.

Maps have a series of conventions that help us to construct and interpret them, including symbols, colour coding, orientation and scale presentations. They allow us to present and analyse data in a visual format, giving us the ability to understand the information spatially, as separate parts of the environment.

Interpreting, analysing and concluding

Setting a series of inquiry questions and gathering information to try to answer those questions is important, but how we understand our information is vital to any geographic study. As a geography student, you need to be able to identify and propose explanations for spatial distributions, patterns and trends, and infer relationships. What are our data showing? Does the information point to further questions that require investigation in order for our work to be considered complete?

If the initial inquiry questions are clear and detailed, and if the research was appropriately targeted, then we will have the information required to make informed conclusions. Let's take a closer look at what that means:

- Was your inquiry specific and measurable?
- Did your research include data collection?
- Did you also check your data with another research tool such as the internet?

If you can confidently answer 'yes' to all of the questions above, then you are ready to begin analysing your data and reaching logical conclusions. Start by answering your inquiry questions, not with a yes or no, but explaining why or how you are sure of your response. What are the data you have that back up your answer? Does it clearly show that you have an answer, or is there a qualifying statement to be made? For example, 'The survey data from our visit to the city, where we took responses from 250 people over a 1-hour period, show that 83% of those people would prefer …' and 'from this, we can say that the local council should seriously consider … as a part of its management plan for the area.'

It is important to not only analyse your information, but to also decide what it is telling you. Are you able to make any reasonable and logical statements based on your data? Are some aspects of it unclear? Sometimes we need to be honest enough to say that our research might not have covered all angles and we need to investigate further before we can really be sure about what is going on. Acknowledging a weakness in your initial inquiry or data collection shows your ability to reflect upon your work and identify areas or directions for further work.

Quantitative and qualitative methods

To assist with interpreting, analysing and developing conclusions, geographers use **quantitative methods** and **qualitative methods** to gather data. If we examine a river, we can talk to people who use the river to gain an understanding of how and when they use it, giving us qualitative methods for collecting information, while quantitative methods could include collecting information on the numbers of fish population sighted or the flow rate of the water. This information may be gathered using measures that give numerical results. Both types of methods are important for the geographer to present a complete picture of the river.

quantitative methods methods used to gather data that is expressed in numerical form

qualitative methods methods used to gather data that is expressed in non-numerical form (can only be described)

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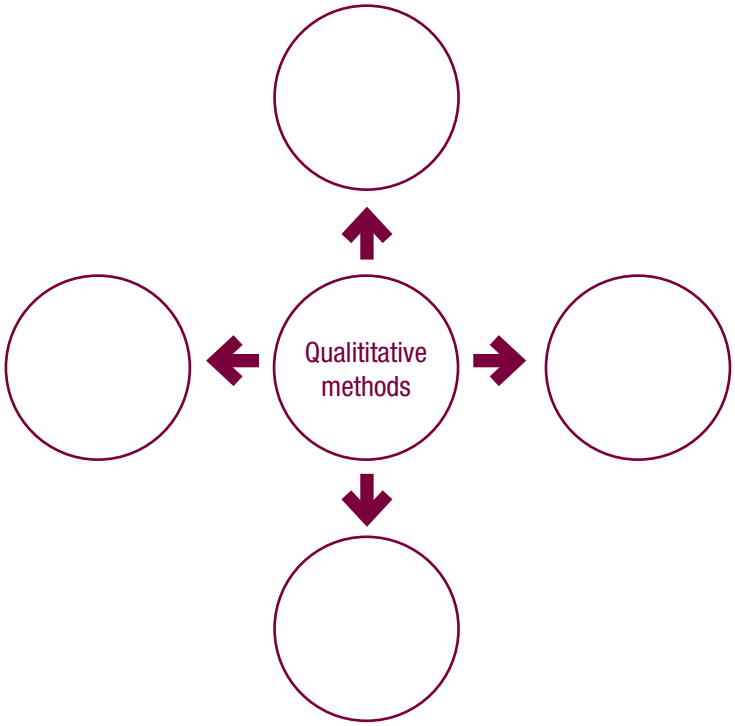
NOTE THIS DOWN

Copy the graphic organiser below and summarise some examples of quantitative methods. Use the same organiser to summarise examples of qualitative methods.



ACTIVITY 0.1

1. Discuss the importance of inquiry questions.
2. Identify some of the ethical protocols we need to be aware of when collecting information.
3. Explain why it is important to use standard geographic conventions when creating a map.
4. If we research the sustainability of our town's water supply, what quantitative and qualitative methods could we use to support our conclusions?

Communicating

There are many ways to communicate the results of investigations. These include but are not limited to written, oral, graphical and visual methods. When deciding on which method to use to present findings, arguments and explanations, we need to consider the subject matter, purpose and audience. It is also important to use relevant geographical terminology and digital technologies where appropriate.

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Communication forms

Written

The most common method to convey research results is the written report. Other methods include essays and extended responses. There is a need to ensure that written pieces are easy to understand, logically organised and fluent, and use the written conventions for spelling, punctuation and grammar. It is always a good idea to use a plan that keeps the work on track, especially if there is more than one writer.

Oral

It is just as important to have a plan with an oral presentation as it is with a written report. The aim is to present your findings to an audience, so there is a need to make sure the audience can access your information. When using computer tools to create visual displays or presentations, be aware of the strengths and weaknesses of the program you are using. Make sure you use a font that is easy to read and a background that doesn't clutter the information. Always keep the amount of text onscreen to a minimum, saving the space for visuals and allowing your presenter to reveal the information while speaking.

Graphical

Some data are better presented visually, through graphs and diagrams, rather than in words. If you are using a graph in a written report, always refer to it and discuss what it shows, ensuring that it is an important part of the report, not just a pretty image designed to fill some space. If it is worth using, it is showing something important and deserves to be discussed.

Visual

Other visual items add interest and understanding to your work, allowing your audience to clearly see what your work is about and how you have gone about your research. Make sure that all images are clearly labelled with a title and also have a purpose for being included in your work. Annotation (notes added to the picture) for field sketches you have taken or other images are useful in a report so you can easily highlight and refer to important sections. You should always acknowledge the source of an image if you did not take it yourself, in the same way as you list information sources in a bibliography.

Using geographical terminology

Any subject you study will have specific terminology for particular ideas and topics. These words form a vocabulary, which makes it easier to convey ideas and meaning in the subject area. Important vocabulary is listed at the beginning of each chapter, highlighted and listed separately in the margins of the pages, and collated in the glossary at the back of the textbook.

Key terms

- Commodity
- Conservation
- Continuous resources
- 'Country'
- Degradation
- Depletion
- Environmental resources
- Non-renewable resources
- Renewable resources
- Sustainability

Source 0.6 You should take the time to memorise and build your geographical vocabulary as it is introduced in each chapter.

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ACTIVITY 0.2

With a partner, spend 5 minutes memorising the words in the vocabulary list below. When you and your partner are confident that you know all the vocabulary, select some words and test each other to see who remembers more.

aesthetic values the valuing or appreciation of something due to its beauty

agriculture the farming of animals and plants (crops)

aqueduct a human-made channel or passage for conveying water

biodiversity the number and variety of species of plant and animal life within a region

climate change a gradual change to the world's normal climate state, that may affect the future of the planet

conservationists people who work to protect the natural environment and its living organisms

continuous resources resources that are in no danger of being used in excess of their long-term availability

cultural value the emphasis placed on something for its importance and place in society, such as the inclusion of water in rituals, heritage and the Dreaming

demographic profile a collection of demographic information used to create a description of an average member of the population

economic value a dollar amount placed on an asset to show how much it is worth

environmental conservation preserving and restoring the environment to ensure no further degradation

environmentalist a person who acts to preserve the quality of the natural environment

evaporation the part of the water cycle where water changes from liquid into a gas and escapes into the atmosphere

industrialisation the modernisation of a country, involving large-scale infrastructure development, economic growth and a movement towards more efficient, mechanised methods of production

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services and education systems

irrigation watering of crops

liveability conditions in a place that make it easy or difficult to live there

meteorologists people who study weather and climate

recreational value the emphasis people place on something in terms of its leisure purposes and enjoyment

renewable resources resources that can be replenished in a relatively short amount of time through reproduction or other biophysical processes

sanitation the provision of adequate facilities such as toilets, and services such as garbage collection, to promote community health and hygiene

sustainability the wise use of resources so they are available indefinitely into the future. Society, environment and economy must all be carefully considered.

topography the shape of the land

urbanisation the process whereby more and more people are coming to live in towns and cities

water scarcity a situation in which there is insufficient water to maintain current standards of living

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Digital and spatial technologies

The use of digital and spatial technologies in geography is becoming more important, both in geographic work and in the wider community. Not only is this an employment growth area, but digital information has also become a part of everyday life for many people. There is also a range of digital communication technologies such as blogs and wikis, electronic surveys and social media applications that can be used effectively to gather data and share results. The trick is to make sure we use them because they are the best tools available for the specific task at hand.

Source 0.7 We easily view satellite maps and weather radar on smart phones from anywhere in the world without thinking about the technology that makes it all possible.

Reflecting and responding

As already mentioned, we should always reflect on the information we have, looking critically to understand what it shows and to see what work still needs to be done to make it more useful.

This also applies to data, whether we collected them or whether they are being presented to us by others. Can the information be checked through another source, or do we trust it because of a known collection method? What is the information showing us? How can we respond to it? How can we use it? These are the crucial questions that must be asked if we are to make effective use of the information rather than allow the data to exist without analysis or response.

Thinking about the material allows us to absorb and bring together the key ideas, leading us to a point where we can put forward solutions to challenges in the world. When putting forward solutions, it is important that we take into account environmental, economic and social considerations. The purpose of our inquiry is to understand the current situation and to propose thoughtful options for the future.

A possible method for achieving this is through a KWL chart, outlined below.

What I **K**now	What I **W**ant to know	What I **L**earned
Put information in here that you knew already before you began your research.	This column is for inquiry questions you need to find the answers to.	The information listed here is what you found out during your research.

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Once our information is categorised into the KWL chart, we can start to analyse it more efficiently.

The KWL can help us to organise our information and can guide us to what we need to be finding out next. If we are looking to develop plans for the future, we may need to check some more things or investigate further. Sometimes, the information we have in the 'What I know' column may need to be checked and confirmed before we can move ahead with our learning.

If we are trying to decide if our town's water supply is sustainable, how would we start our research? By listing what we know about where the town's water comes from, we can then see what we still need to find out to decide if the water supply is sustainable or not. When we have filled in the final column with our researched information, we are then able to respond to our inquiry question about the supply.

Fieldwork

Fieldwork is at the heart of geographic inquiry. It is any activity conducted outside the classroom, whether that is in your local area or a more distant location. It forms the framework for valid scientific research and supports the development of inquiry questions that make sure we are able to consider a range of strategic solutions and management plans to maintain sustainable environments.

In this textbook, you will find a number of fieldwork activities that provide step-by-step instructions on observing and recording information. There are a number of ways to communicate your observations and data, including in the form of a fieldwork report. This method is used in the textbook and explained below.

Front page	***Title and name*** Ensure you have your own name (or names of group members) clearly identified. The front page should also contain a clear title indicating what your research was focused on.
Contents page	***Do this last, as well as numbering pages***
Page 1	***Aims and methods*** What was your intention when you started the research? List your inquiry questions here and, if you are able to predict what you may find, do that here too. Describe the way you collected data to test your questions and hypothesis.
Page 2	***Location map*** One of the key tools for the geographer is mapping. Make sure your map is clear, easy to read, follows the mapping conventions of BOLTSS and uses the recognised symbols and colours of maps, such as blue for water. **BOLTSS** **B**order – the border should surround your map and everything that is a part of the map (title, scale, legend etc.). It encloses the information and shows that it all relates to the map. **O**rientation – show where north is using one of the conventional symbols, for example an arrow or full compass. **L**egend – the legend or key shows what all the symbols and colours you have used on your map mean. **T**itle – make sure your map has an accurate title that explains what the map is showing, for example *Shopping Centre Traffic Flow, 1–3 p.m., Thursday 26 December 2013*. **S**cale – the map's scale shows how big the area shown on the map is in the real world.

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Page 2 (cont.)	**S**ource – indicate where you obtained the information for the map. This could include your own measurements, a search engine, a GPS mapping system or the local council offices.
Page 3	***Introduction*** Give a brief description of the study sites and any noteworthy features.
Pages 4 and 5	***Description of uses and photos*** What the area is currently used for – a written description accompanied by photographic evidence is good practice.
Page 6	***Table of usage*** Effects of current use (positive or negative, short-term or long-term). A table is an excellent way to display this information. Keep your points simple and refer to any photographs or other data in your fieldwork report that support this information.
Pages 7 and 8	***Description of effects of use, sketches and/or photos*** This section needs to be quite detailed and show that you understand the area your fieldwork is based on. Annotate any field sketches or photographs you use to highlight and explain the space.
Page 9	***Association between use and effects of use*** Make the links between how the space is used and the effects of those uses on the space. It may seem obvious, but you need to be explicit and openly state what is going on.
Page 10	***Table or written description of management strategies*** What are the current management strategies being used in this space? Depending on how many applicable strategies there are, you may choose to organise them in a chart or table to separate them and make it easier to discuss them later.
Page 11	***Photos or sketches of management strategies*** Do not underestimate the impact of images in your work. It is often easier to show how a management strategy is working than to explain it in words, and it could be more interesting for the reader. Make sure your photos or sketches are clearly labelled or annotated.
Page 12	***Evaluation of these strategies*** How well are the current management strategies working? Are there any parts of them that are supporting the space well? Perhaps other sections of the plan need rethinking? What would you change if you had the chance? Evaluate; don't just describe. Make sure you are giving clear and balanced feedback on the current strategies.
Page 13	***Appendix, bibliography, glossary*** An appendix is the section at the end of a book providing additional information that supports the main work. You should include an appendix to add meaning to your work. If you undertook a survey as a part of your fieldwork, the results could be included here. The bibliography is an important piece of any research. Make sure you list all information sources, websites and people who informed your work. Here's one method: Author/s: surname first, then initials (publication year in brackets). *Title in italics*. City location of publisher: publisher's name. A glossary is a mini-dictionary for your work. You should include in the glossary any words that your reader needs to know or to understand your usage of them.

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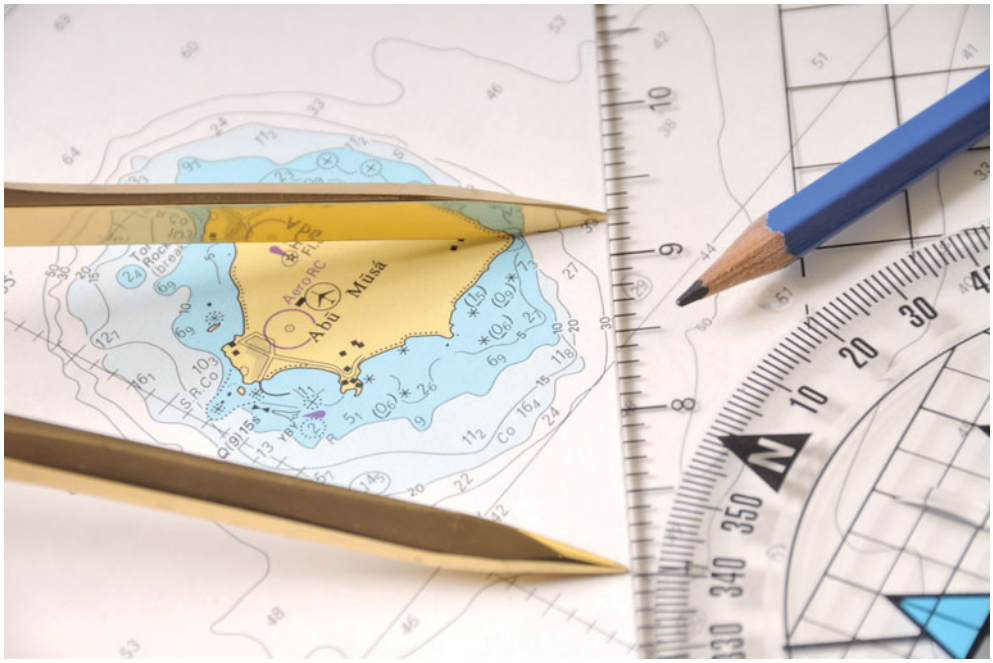

Source 0.8 The geographer at work, marking points on a map

ACTIVITY 0.3

1. What are the considerations you need to take into account when reflecting and responding to an issue or problem?
2. List 5 digital and spatial technologies and, using a KWL chart, different ways you could use each one in developing an inquiry research task.
3. Identify 2 other ways of communicating your observations and data when undertaking a fieldwork activity, other than in the form of a report.

0.3 Concepts for geographical understanding

It is useful to have a framework that supports and guides us in our geographic studies: a range of tools and ideas that allow us to target our inquiry and support our learning. The concepts for geographical understanding (place, space, environment, interconnection, sustainability, scale and change) provide this, helping us to understand and build on the work of others in the same field of study. In addition, it makes it possible for us to confidently understand the work we do and its place as valid geographic research.

Place

The world is made up of places that are given different meanings by people. For Aboriginal and Torres Strait Islander peoples, places can be given spiritual meaning and shape their culture and identity. Places range in size from your classroom to a world region. Places are important locations for major events, social and human interactions as well as areas that have importance in the natural environment.

Where something is – its location – is very important to our studies. We can use the co-ordinates on a map, called **latitude** and **longitude**, to show

latitude an imaginary line measured in degrees north and south of the Equator

longitude an imaginary line measured in degrees east and west of the Prime Meridian (or the Greenwich Meridian)

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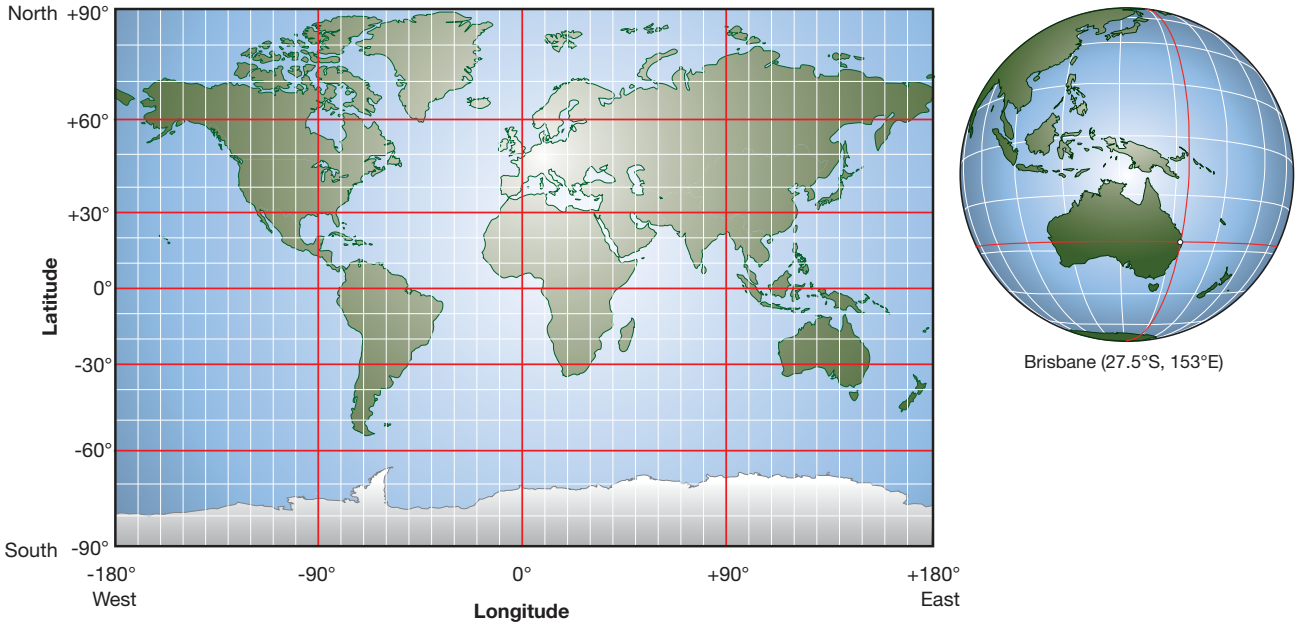

Source 0.9 The best-known system for locating a place is latitude and longitude. This involves an imaginary grid that covers the Earth, allowing people all over the world to use and share consistent references.

others where something is. Latitude and longitude divide the world up into a grid, and when using them, latitude is always stated first. You can see in Source 0.9 that the position of Brisbane is 27.5°S, 153°E.

Sometimes a description can help to show others where something is, or landmarks can help us to explain a place's location; for example, it is next door to the house with the red letterbox. Maps often have their own simple system of coordinates to help us find particular places easily. We can be directed to the north-east corner of the forest (for example, C4), allowing us to find the correct section of forest.

Space

In geographical terms, space is the distance between things and can involve spatial patterns. The space around us, rather than outer space, is the key. Space refers to the organisation of an area, where things are (location) and their distribution in it. It is about how the area is perceived, structured and managed. If we examine a town, we can see patterns in the street layout or the green spaces, how far apart services like schools, churches or shopping centres are and the pattern of major transport networks like highways and railways. In the natural world, we can see mountains with a range, the web of streams and rivers in a catchment area or the frequency of lakes within a landscape. Space refers to the distribution of items as well as their frequency and helps us to describe the patterns we see.

Environment

The environment is an integral part of our world. It is a term that is often used and rarely defined, so what do we mean by 'environment'? It is made up of the external factors that exist within an area or region – for example air, water, minerals, plants and animals – and how they work together to form a system. The term is often used to describe natural systems like forests and oceans, but it also applies to human-altered (anthropogenic) systems such as cities. Sometimes, environments are not easy to classify and we need to recognise the importance of both natural and human-altered elements (geological/rock, atmospheric/air, hydrological/water, edaphic/soil, biotic/living and human). A natural water system such as the Murray–Darling Basin supports not only the plants and animals of the region, but the towns and human populations

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as well. The river is modified to provide year-round irrigation for farmers and drinking water for the city of Adelaide.

Interconnection

Interconnection is based on the concept that nothing can be viewed on its own, but has a relationship to other things and systems. It recognises that within an environment or space there are real connections and influences that alter the way the space operates and is viewed. We use it to analyse these connections and examine the level of influence to decide the level of impact and predict future patterns. It supports looking at geographic phenomena and features such as urbanisation, global warming or erosion as processes within real environments. Interconnections can be very detailed and lead us to look at spaces or environments as a whole system, rather than viewing each element separately.

Sustainability

Sustainability refers to the ability for long-term balance, often in the environment, and the ability to maintain natural resources at a certain level into the future. Sometimes sustainability is thought of as being a 'hippy' concept, something that only environmentalists would concern themselves with, but it is increasingly used to mean any system (natural or human-made) being in a healthy state of balance. It helps to direct people to accept their responsibility for their environment and to formulate plans to protect it for the future.

Scale

The main focus of the geographic concept of scale is to see things at different levels, from the personal to the local, national and global levels. How we view an issue or the types of solutions we can put forward changes as we move through these different scales. Collecting water for personal use is at a low scale and very controllable, with variables such as chemicals and additives being our own responsibility. Water harvesting on a national or global scale is very different, with a supply chain that includes governments and supply on many levels.

We also need to understand that choices and management plans at one level can influence the situation at another level. For example, this occurs when the federal government passes legislation that affects how the individual is able to operate or changes processes on a local level, such as the introduction of the Murray–Darling Basin Plan.

Source 0.10 The concept of sustainability helps us to question the current state of a space and to pose management solutions to issues and challenges that we are able to identify.

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Source 0.11 The Murray–Darling Basin Plan affected individual farmers, small towns and major cities and was produced by the Australian federal government.

Change

Change involves both space and time. It is a concept that covers the impacts of movement and history, with human-altered and natural environments both being affected. Looking specifically at our local area, it is clear that it is dynamic. Homes are built, roads are upgraded, gardens are rejuvenated and this is just the beginning. In fact, there is so much change over time in our local neighbourhoods that it would seem very unusual if it all stopped.

Change involving space might initially seem more difficult. Think about what happens in your local area if a new shop opens. Consumers who were purchasing goods in another neighbourhood will begin to change their shopping patterns. As a result, traffic patterns and parking requirements may also change from 1 location to another. This is spatial change on a local scale.

ACTIVITY 0.4

1. In your own words, describe the concepts for geographical understanding.
2. Explain how latitude and longitude are used by geographers. What is the link of latitude and longitude to world time zones?
3. Evaluate the long-term sustainability of your home. Develop a plan to improve its sustainability, including power supplies, water and food production.

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UNIT 1
Water in the world

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1 Water: a renewable environmental resource

Source 1.1 Earth is known as the 'blue planet' due to its larger water to land area.

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Before you start

Main focus

Water is an environmental resource, essential to all life on Earth, valued, used and managed by different people in different ways.

Why it's relevant to us

Only 1% of the world's water is freshwater available for human use. This limited resource is under threat due to increasing population, overconsumption and pollution, and must be carefully managed to ensure its availability now and into the future.

Inquiry questions

- Can water always be classified as a renewable resource?
- How does the movement of water through the environment connect places, and what are the implications of these linkages?
- How can Aboriginal and Torres Strait Islander people's knowledge about use and management of water contribute to the sustainability of water resources in Australia today?

Key terms

- Commodity
- Conservation
- Continuous resources
- 'Country'
- Degradation
- Depletion
- Environmental resources
- Non-renewable resources
- Renewable resources
- Sustainability

Let's begin

Russian astronaut Yuri Gagarin gained his place in history in 1961, when he became the first human to leave Earth and journey into space. As he looked back at our planet and marvelled at its beauty, Gagarin exclaimed, 'The Earth is blue ... How wonderful. It is amazing!' Gagarin's observations of a 'blue planet' should come as no surprise considering approximately 70% of Earth is covered with water. The total amount of water held within our planet is referred to as the Earth's water inventory. This amount never changes, but is continuously changing state and moving from one place to another as a result of the water cycle. However, while this resource appears to be abundant on Earth, 97% of Earth's water is saline, containing significant amounts of dissolved salts, and therefore has limited uses. Salty water is not drinkable and cannot be used for agriculture or industry without damaging land or capital equipment. That leaves only 3% of Earth's water inventory as freshwater, but because 2% of this is locked up by ice caps and glaciers, only 1% is available for human use. We use this small amount of water for drinking, sanitation, transportation, heating and cooling, industry, recreation and many other purposes.

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1.1 Why water is important

Water is arguably the most important substance on Earth. From the simplest to the most complex of organisms, every living thing on Earth needs water to survive. Green plants, which are the basis of all food chains and webs, rely on soil moisture, groundwater and surface water. In the process of **photosynthesis**, these plants combine carbon dioxide and water with light to produce glucose and oxygen. Glucose provides the energy plants need to produce new tissue, and the oxygen produced is used by animals in the process of **respiration**.

photosynthesis the process by which plants convert solar energy and carbon dioxide into glucose and oxygen

respiration inhalation and exhalation of air by humans and animals; breathing

Animals and humans also need water to function. In humans, water is so important to the functioning of the body that it makes up approximately 60% of our anatomy and around 83% of our blood. The human body cannot go without water for more than a few days or it will perish. Water also promotes life in a variety of other ways. Without it, we couldn't grow crops, raise livestock or wash our food. Oceans, seas and rivers also provides us with a supply of seafood. We need water for drinking, health and **sanitation**, cleaning, cultural and spiritual significance, and for just about any land use or activity we undertake.

sanitation the provision of adequate facilities such as toilets, and services such as garbage collection, to promote community health and hygiene

Source 1.2 Water is essential for all life on Earth.

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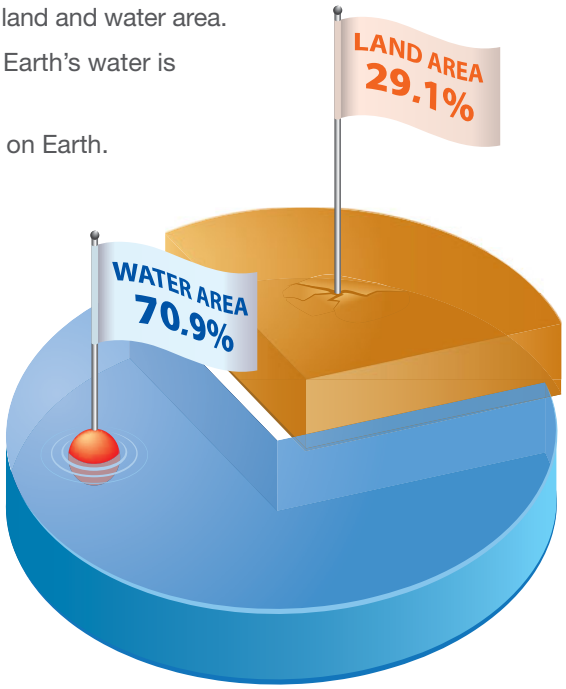
Geographical fact

The average distance a woman in Africa or Asia walks to get water is 6 km and the weight of water she carries on her head is approximately 20 kg (according to Women's Human Rights net, WHRnet).

Source 1.3 Indian woman walking home from the well

ACTIVITY 1.1

1 Refer to Source 1.4. Compare the Earth's land and water area.
2 Explain why only a limited amount of the Earth's water is available for human use.
3 Explain the importance of water to all life on Earth.



Source 1.4 Comparison of the Earth's land and water areas

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1.2 Environmental resources

Geographers are concerned with the sustainability, or maintenance into the future, of the Earth's environ-mental functions that support human life. The first of these functions is the production of **environmental resources**. These are natural resources that have originated directly from the biophysical environment. Examples include water, soil, timber, fish, minerals and fossil fuels. Earth's natural systems are responsible for their existence, as well as their uneven distribution across the planet.

environmental resources natural resources that have originated directly from the biophysical environment

Renewable resources

Environmental resources are classified as **renewable** or non-renewable depending on the time taken for them to re-generate and the degree to which they can be sustained with continued human use. Renewable resources are also called 'unlimited resources'. They can be replenished in a relatively short amount of time through reproduction or other biophysical processes. For example, the life cycles of plants and animals enable the continuation of their species while the operation of the water cycle results in the continuous movement and renewal of water sources.

renewable resources resources that can be replenished in a relatively short amount of time through reproduction or other biophysical processes

Non-renewable resources

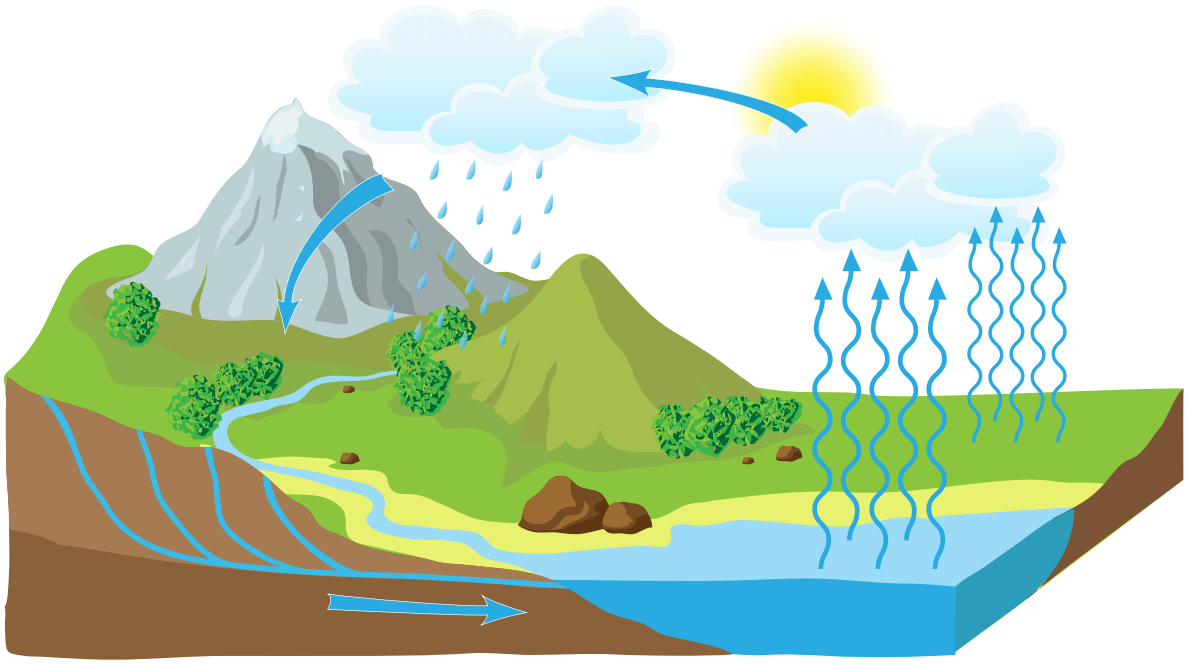
The second category of env-ironmental resources is **non-renewable resources**. Also known as 'limited resources', non-renewable resources cannot be replenished in a human lifetime. They are formed over geological time scales ranging from hundreds to millions of years. Minerals, including precious stones and metals, and fossil fuels such as coal, oil and natural gas, all fall under this category. Since their rate of formation is extremely slow, they cannot be readily replenished once they are depleted.

non-renewable resources resources that are unable to be naturally replenished and sure to be used up at the human rate of use

Continuous resources

Geographers also refer to a third category of environmental resources known as **continuous resources**. These resources, such as solar radiation, tides and

continuous resources resources that are in no danger of being used in excess of their long-term availability



Source 1.5 The water cycle enables renewal of Earth's ground, surface and stored water sources.

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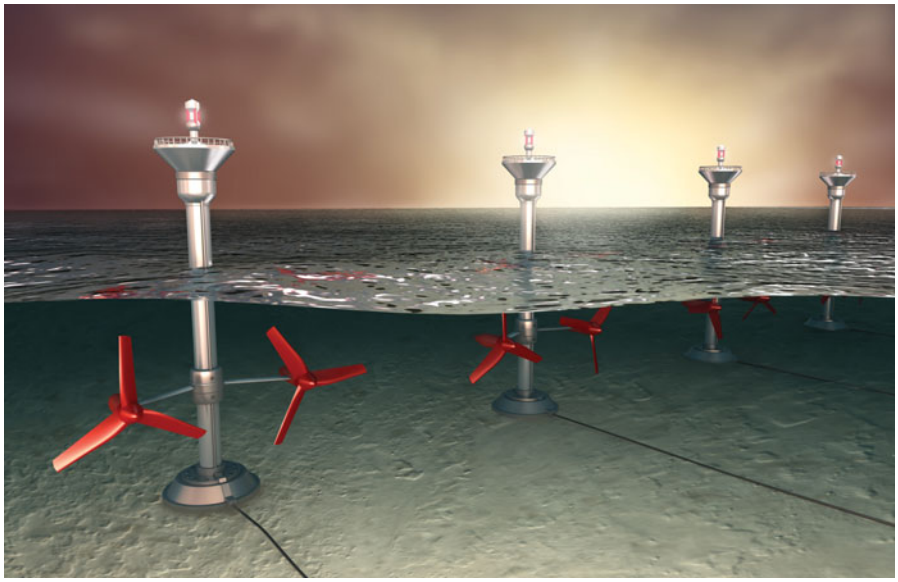

Source 1.6 Tides are an example of a continuous environmental resource. This illustration of a tidal turbine shows how the energy of continuous resources can be harnessed.

winds, are available continuously though at a limited rate. Their quantity is not affected by human consumption and they are in no danger of being used in excess of their long-term availability.

Is water a renewable resource?

Water is often classified as a renewable resource because the operation of the water cycle enables the replenishment of ground, surface and stored water sources. However, as the world's population expands, enormous pressure is placed on all the Earth's resources, even the renewable ones. As more people need access to water, reserves are reduced or depleted. Rates of replenishment depend on global rainfall distribution patterns, groundwater infiltration and consumption rates.

Also putting pressure on water supply are forms of environmental degradation, such as pollution. Almost half the world's water is contaminated in some way by pollutants like raw sewage, agricultural and urban stormwater run-off, and discharge of industrial wastes. Polluted water is not only unsafe for humans, but can also have negative effects on biodiversity and comes at a significant economic cost. The status of freshwater as a renewable, unlimited resource is therefore vulnerable if the resource is not carefully managed.

Source 1.7 Untreated industrial waste is discharged into a river, causing water pollution.

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NOTE THIS DOWN

Copy the graphic organiser below and summarise what you have learned about environmental resources.

Environmental resources			
	Renewable	Non-renewable	Continuous
Also known as	Unlimited resources	Limited resources	Perpetual resources
Rate of replenishment			
Examples			

1.3 Water through history

Water has played a key role in the development of societies throughout history. Source 1.8 illustrates the settlement of the earliest civilisations along major rivers, which provided for the economic, social, cultural and spiritual needs of the people. For example, by 5000 BCE, ancient Egyptians were living along the Nile River. The people depended on the flooding of the Nile for rich fertile soil, which they called 'the gift of the Nile'. Their ability to harness water through development of irrigation devices, such as the ***shaduf***, enabled them to grow staple crops, especially wheat and barley, and industrial crops such as flax and papyrus. Hunters pursued a great variety of wild birds, and fishermen netted their catches. It provided fresh water for drinking and bathing, and materials for building, making cloth and paper, and supported transportation and trade.

shaduf a device used in Egypt and other Eastern countries for raising water, especially for irrigation, consisting of a long suspended rod with a bucket at one end and a weight at the other

As civilisations expanded, societies came up with new technologies to access water. For example, the ancient Romans were famous for building raised canals called **aqueducts** to bring water from distant sources to their cities and towns. Water supplied public baths, toilets, fountains and households. The Romans built sewerage systems, which enabled them to remove waste water from settlements, and some aqueducts served water for mining, processing, manufacturing and agriculture.

aqueduct a human-made channel or passage for conveying water

During medieval times, water was used as a means of defence. Deep, broad ditches called moats were filled with water and often surrounded castles or towns, acting as obstacles to enemy access. In the late 18th and early 19th centuries, water was an important resource during Britain's industrial revolution. Inventions such as Arkwright's water frame revolutionised the textile industry, reducing human labour and increasing production. Other inventions, including Watt's steam engine, were used to run machinery as well as for transport, and the development of canals enabled heavy produce to be transported over large distances.

Water has also expanded civilisations by providing them with a means of global travel. During colonial times, explorers including the British, Portuguese, Spanish and Dutch travelled by ship. They often exchanged goods and ideas, and conquered or colonised the places they found. Much of the modern world we know today has been influenced by the travellers who journeyed over the seas by ships centuries ago.

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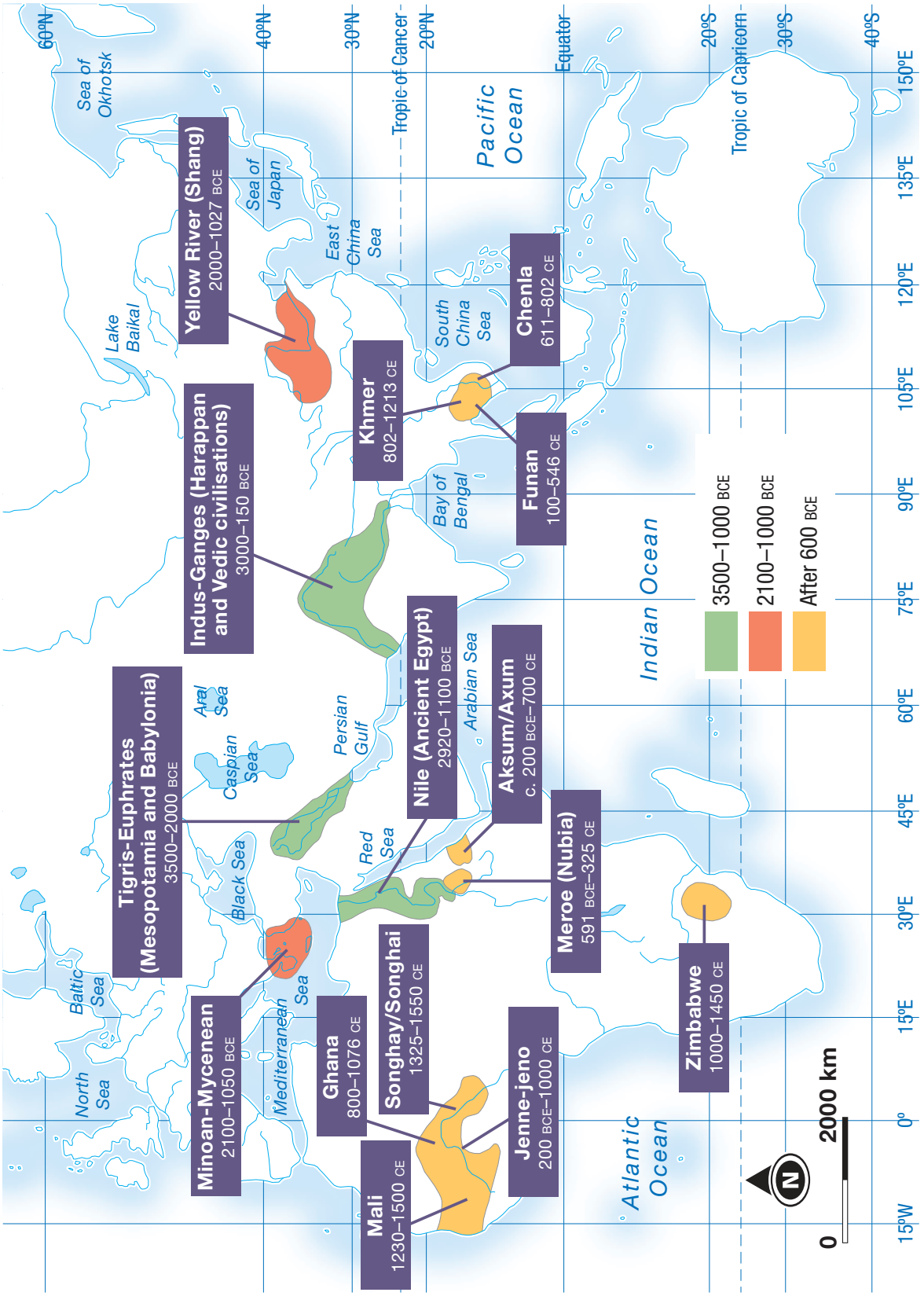

Source 1.8 Some of the world's ancient civilisations

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Source 1.9 Roman aqueducts like the Pont du Gard in France can still be seen today.

ACTIVITY 1.2

1. Describe the relationship between the locations of ancient settlements and water sources. Refer to actual examples from Source 1.8. Suggest reasons for your answer.
2. Identify 3 water-related innovations of past civilisations, and the impacts they have had on society past and present.
3. Explain the role water has played in the global expansion of human settlements.
4. Use your atlas to discuss the relationship between the location of settlements in the world today and their proximity to water sources.

1.4 Water conflict and cooperation

Water connects places as it moves through the environment. There are currently more than 250 river basins and countless **aquifers** that cross the political boundaries of 2 or more countries. For example, 19 countries share the Danube River, 13 countries share the Congo River and 9 countries share the Amazon River. Shared water resources have been a source of cooperation and conflict throughout history and continue to unite and divide places in the world today.

aquifer geological formation containing groundwater that can supply water to wells or springs

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Case study 1.1

Construction of the Grand Ethiopian Renaissance Dam

Situated in North Africa and flowing through 11 countries, the Nile River system is regarded as the longest in the world. Two major tributaries, the White Nile and the Blue Nile, flow from the Great Lakes region of Central Africa and the Ethiopian Highlands respectively, where they meet near the Sudanese capital of Khartoum. Here it becomes the Nile River and continues flowing north to the Mediterranean Sea. The Nile is considered the most significant life source for its downstream countries, especially Sudan and Egypt.

The Nile's water has affected the politics of north-east Africa for many decades. Several attempts have been made to establish agreements between the many countries that share the Nile. However, it has been very difficult for all countries to come to an agreement. In March 2011, Ethiopia made public its plans to construct the Grand Ethiopian Renaissance Dam, which will eventually create a lake containing more than 60 billion m^3 of water. It is predicted to be the largest hydroelectric power plant in Africa when completed. Egypt and Sudan oppose the dam, which they believe will reduce the amount of water they get from the Nile. Ethiopia argues that the dam will not reduce water availability downstream. The countries involved are in the process of attempting to resolve the dispute.

1. Using your atlas or online maps, construct a sketch map of North Africa showing the extent of the Nile River. Label the following: White Nile, Blue Nile, Nile River, Nile delta, Mediterranean Sea, the names of the countries through which the Nile flows, and the direction of flow. Remember to include BOLTSS (border, orientation, legend, title, scale and source).
2. Suggest why you think it has been difficult for all countries that share the Nile to reach a formal agreement regarding its use and management.
3. Conduct research online to determine the current progress on the Grand Ethiopian Renaissance Dam project. What viewpoints are held by the countries that share the Nile as a resource?

Source 1.10 The Nile connects nine other countries before flowing north through Sudan and Egypt.

Source 1.11 The Nile flowing through South Sudan

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RESEARCH 1.1

Use your atlas or online maps to find out which countries or Australian states share the following water bodies:

- Tigris and Euphrates rivers
- Jordan River
- Indus River
- Yangtze River
- Imjin River
- Aral Sea and source rivers Syr Darya and Amu Darya
- Limpopo River
- Murray–Darling river system.

In small groups, select 1 of the water bodies listed above. Research any conflict or cooperation that has resulted between the countries or states it connects. Share your findings with the class as an oral presentation.

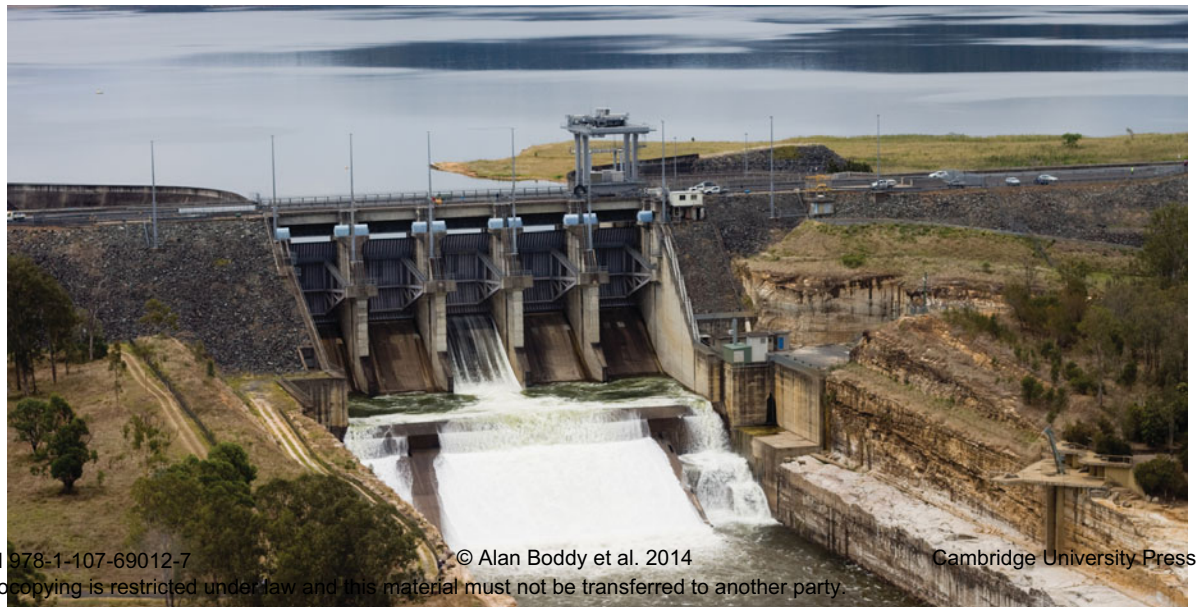
Source 1.12 The Murray River at Swan Hill

1.5 Water as a commodity

Historically, water was extracted as a common resource by whichever local community lived around it. As societies progressively developed, access to water took on a more economic approach. Water became a **commodity** – a marketable item, bought and sold to satisfy the needs and wants of people. Today, in Australia, state governments regulate water supplies from ground, surface and stored water sources, as well as from desalination plants. This water is usually treated before being piped and sold to residential as well as agricultural, commercial and industrial customers. When you turn on a tap at home, this is the water you are most likely using.

commodity a resource that can be bought and sold

Source 1.13 The Wivenhoe Dam near Brisbane creates a primary source of stored water for consumption in south-east Queensland.



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Source 1.14 The bottled water industry is expanding.

In recent years, the market for water has greatly expanded. People around the world now also demand bottled water. Bottled water is usually sourced from natural underground springs, although some brands are sourced from other supplies and then treated. Bottled water has become increasingly popular, as consumers testify in favour of its convenience, better taste compared to tap water, and benefits as a healthy alternative to other drinks. Such claims, however, have been opposed by groups including health professionals and environmentalists. Despite such debates, the popularity of bottled water and its market continues to grow.

1.6 Natural resource management

In order to satisfy local, regional and global demand for goods and services, land uses and activities use environmental resources, including water. As population increases, so does demand. If resources are not carefully managed, they can be subject to environmental **depletion** and **degradation**. Two areas of natural resource management are **conservation** and **sustainability**. Conservation is about preserving and restoring the natural environment from loss, damage or neglect. It involves wisely managing and protecting natural resources and the environment so they will be available on a long-term basis. Sustainability is similar to conservation; however, as well as ensuring environmental functions indefinitely into the future, sustainability also requires satis-faction of environmental, economic and social criteria. Meeting all 3 criteria is an extremely challenging goal in today's world.

depletion a reduction in the quantity of an environmental resource

degradation a reduction in the quality of an environmental resource

conservation preserving and restoring resources from loss, damage or neglect

sustainability the wise use of resources so they are available indefinitely into the future. Society, environment and economy must all be carefully considered.

Source 1.15 The goal of sustainability requires that environment, society and the economy are all carefully considered.

Geographical fact

Eighty per cent of diseases in the developing world are caused by contaminated water (according to WATERAID).

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Environmental criteria

All land uses and activities have some form of impact on the natural environment. Plans for conservation and land management should therefore always be considered, including ongoing rehabilitation to ensure the environment is suitable for future use. Conservation in one place should not be achieved at the expense of the environment in another place, and mitigation of and adaptation to climate change need consideration.

Economic criteria

The use of environmental resources to satisfy needs and wants should maintain or improve people's standard of living. Essential resources, such as water, should be affordable so that they are accessible by all. Additionally, people, organisations or governments making a profit should attempt to provide economic opportunities for local people, such as a range of employment with fair wages.

Social criteria

Any land use or activity undertaken should seek to benefit a range of people in society, and not exploit, endanger or disrespect any group. Health, safety and equity must not be compromised. Traditional landholders and their extensive knowledge of the land should be respected, and the recreational, psychological, aesthetic and spiritual value of environments should be protected.

Water conservation and sustainability

Water conservation and sustainability affects all levels of society in regions and countries across the world. Better management of water resources requires finding a balance between what people need and what is needed by the environment. The question this raises, however, is one of responsibility: who is responsible for addressing the issue of global water scarcity?

Global action

Non-government organisations, such as the United Nations, promote global awareness through initiatives like the international World Water Day. Held annually in March, the event focuses on the importance of freshwater resources and their sustainable management. Other global initiatives

Source 1.16 Consultation with traditional landowners is one aspect of social sustainability.

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Sustainability requires that:

1 Renewable resources should only be exploited at or below their rates of renewal.
2 Biodegradable wastes should not be added to the environment faster than they can be broken down and recycled.
3 Non-biodegradable wastes should not be added to the environment at levels that threaten ecosystems and human health.
4 Non-renewable resources should not be exploited faster than the rate at which they can be maintained through reuse and recycling, or substituted by other non-renewable or renewable resources.
5 The use of renewable resources to replace non-renewable ones must satisfy the criteria of environmental impact, economic costs and benefits, and social justice.
6 The life support and ecosystem services functions of the environment should be protected.
7 The recreational, psychological, aesthetic and spiritual value of environments for people should be protected.
8 Sustainability in one place may not be achieved at the expense of environmental conditions in another place.
9 There must be an equitable sharing of global environmental functions.

Source 1.17 Sustainability principles

Source 1.18 World Water Day is a global water sustainability initiative.

include the UN International Decade for Action 'Water for Life' (2005–15) and the Global Water Partnership, which focuses on action in Central America, East Africa and West Africa.

Geographical fact

At least one-eighth of the world's population do not have access to safe drinking water, according to the World Health Organization.

National action

At a national level, the Australian government's initiative 'Water for the future' aims to better balance the water needs of communities, industries and the environment. It caters for both urban and rural areas and is built on 4 key priorities:

1 using water wisely
2 securing water supplies
3 supporting healthy rivers and wetlands
4 adapting to climate change.

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Local action

The most important level at which water needs to be managed is the local one. The phrase 'think global, act local' has long been used to urge people to consider the health of the entire planet and begin taking action in their own local communities. Strategies imposed by local governments include restrictions on outdoor water usage, such as lawn watering, encouraging the planting of native species, and mulching of gardens to reduce evaporation.

At a personal level, people can implement their own water-saving strategies, including limiting shower times, reusing wastewater (grey water) on plants and gardens, and washing clothes and dishes only when there is a full load. New technologies available to consumers have aided the water conservation challenge. Features such as dual-flush toilets, water-saving shower heads and high-efficiency washing machines and dishwashers have helped to make a difference in household water consumption and waste.

Source 1.19 Home water conservation concepts

ACTIVITY 1.3

1. Visit your state or territory's water corporation website. Find out where your state or territory obtains its water for agricultural, industrial and domestic use.
2. In your own words, explain the difference between conservation and sustainability.
3. Investigate the price your household pays for water consumption per litre, and then compare it to the price of other liquid commodities such as soft drinks and petrol. Discuss the advantages and disadvantages of pricing water in this way.
4. Apart from pricing, suggest other incentives that could be used to encourage water conservation.

1.7 Aboriginal and Torres Strait Islander people's knowledge and management of water

Aboriginal and Torres Strait Islander people have lived continuously in Australia for over 50 000 years. At the time of European settlement, approximately 600 different clan groups or 'nations' lived around the continent, each with its own language, cultural traditions, spiritual beliefs and unique identity. Despite the diversity, each group shared in common a rich connection to, and relationship with, its land or place, often referred to as **country**. The strong ties that Aboriginal and Torres Strait Islander people have with the environment can still be seen today through their deep respect for the land and broad knowledge of what the land can provide if it is looked after.

country the Aboriginal concept of place, which includes all aspects of the environment including life

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The Dreaming and water

All cultures have stories about creation. For the Aboriginal people, that time has been translated to English as 'the Dreaming'. Torres Strait Islander peoples do not use the term 'Dreaming', although they do have similar creation stories and beliefs. These stories vary depending on the regions in Australia they originated from, but many have in common the giant spirit creatures or ancestral beings that created the environment we know today, including landforms, water and living things. The spirits are always considered part of the land.

Aboriginal and Torres Strait Islander people's understanding of their water systems can be seen in their creation stories. For example, the rainbow serpent is a key symbol of creation, which features in the Dreaming stories of many mainland Aboriginal nations. The rainbow serpent is known by different names, including the Wagyl, Wanamangura and Kajura in Western Australia; Almudj or Numereji in the Northern Territory; Kanmare, Tulloun, Andrenjinyi, Takkan and Targan in Queensland; Kurreah and Wawi in New South Wales; Neitee, Yeutta, Myndie and Bunyip in Victoria; and Arkaroo in South Australia. The serpent is almost always associated with the creation of watercourses, such as billabongs, rivers, creeks and lagoons. One version in south-western Australian Noongar culture tells about the snake-like Wagyl creating the Swan and Canning Rivers as it slithered across the land. As it travelled underground, it created wetlands such as The Spectacles, Lake Monger and Lake Joondalup wherever it raised its head above the land. Such creation stories have been passed on orally for thousands of years. They illustrate the spiritual connection between the people and their places, and the knowledge that people had long ago of local water systems, both ground and surface.

Source 1.20 Modern Aboriginal art depicting the rainbow serpent

Survival on the dry continent

Approximately 70% of Australia is covered by desert or semi-arid land. Some coastal areas also experience seasonal rainfall characterised by an extended dry season. This meant that its original inhabitants needed to know how to find and manage water if they were to survive. The first Australians quickly learned to read the landscape, using terrain, animals and vegetation as markers for water. For example, they followed dingoes to rock pools and waterholes. Ants led them to underground reservoirs. If they were travelling in a dry area and came across numerous gum trees, they assumed the presence of groundwater. They accessed this groundwater through natural springs or by digging tunnels and scooping out sand or mud, often to a depth of several metres, using a **coolamon** or **woomera**, until clean water gathered in the base of the hole. They mapped the water sources they found mentally and sometimes also through their art, and orally passed information and skills from one generation to another. Many early European settlers owed their local knowledge of groundwater and bush tucker to these oral stories. This tradition and knowledge is still held and passed on by tribal elders today.

coolamon a basin-like dish made from wood or bark

woomera a notched stick used to propel spears or darts

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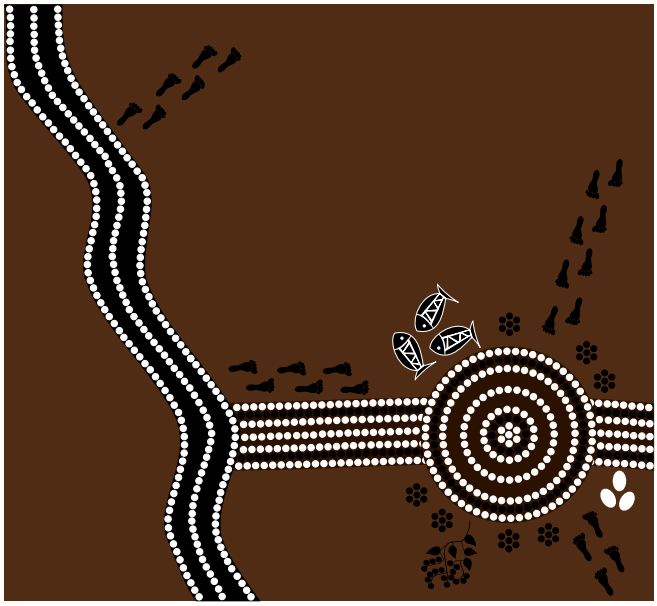

Source 1.21 Modern Aboriginal art depicting places associated with water

Source 1.22 An Aboriginal man draws symbols for waterholes and running water in the sand.

Custodians of the land

In many stories told by Aboriginal and Torres Strait Islander people, a common theme is that the ancestral beings responsible for creation spoke to the tribal elders and made the local people guardians or custodians of the land. This is why their people have a very special meaning for 'country' that goes beyond the supply of food, water and resources. Their spiritual and cultural connections to the land oblige them to look after the sites of their ancestors. Unfortunately, many Aboriginal people's connections to the land were severed during the time of the stolen generations. It is estimated that up to 70% of them have lost their traditional connection to country and knowledge about the use and management of resources like water. Today, elders and their people, who have had this knowledge passed on to them, are working with both Indigenous and non-Indigenous Australians to ensure that the environmental legacy of their ancestors continues.

Water management

Water management cannot be looked at as a separate environmental concept for Aboriginal and Torres Strait Islander cultures, because for them everything is connected to the whole ecosystem. Members of each clan had specific knowledge of their geographic region and adapted to environmental changes in that area. For example, many clans developed a nomadic lifestyle, ensuring that water resources were not depleted before moving with the next season to another location. In this way, they lived with the land rather than living off it. From the perspective of land management and the relationship between humans and nature, their way of life was sustainable.

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Chapter summary

- 97% of the Earth's water is saline and 2% is locked up in ice caps and glaciers, leaving only 1% of water as freshwater available for human use.
- Water is often classified as a renewable resource because the operation of the water cycle enables the replenishment of ground, surface and stored water sources. However, the status of freshwater as a renewable resource is vulnerable if not carefully managed.
- Water connects places as it moves through the environment. There are currently more than 250 river basins and countless aquifers that cross the political boundaries of 2 or more countries and are sources of both cooperation and conflict.
- Water conservation is about preserving and restoring water resources from loss, damage or neglect. Sustainability also involves wisely managing and protecting water resources so they will be available on a long-term basis, but additionally requires satisfaction of environmental, economic and social criteria.
- Aboriginal and Torres Strait Islander people's holistic connection to 'country' enabled them to use water sustainably for tens of thousands of years. All Australians have much to learn about water conservation and sustainability from these traditions.

End-of-chapter questions

Multiple choice

1 The total amount of water held within the Earth:

A never changes in quantity

B never changes in quality

C never changes state

D never moves from one place to another

2 Which of the following can be classified as a renewable resource?

A Coal

B Tides

C Fish

D Gold

3 Which of the following demonstrates water as a commodity?

A The Ancient Egyptians used water from the Nile to irrigate their crops.

B Water is bottled and sold around the world.

C Rainwater is captured in tanks for use at home.

D Aboriginal people read the landscape in order to find water.

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4 In order to use freshwater sustainably:

- **A** consumers must lower their standards of living and use less water
- **B** the price of water should be raised so that people use less because they cannot afford it
- **C** people should not use water for recreational and spiritual needs, and should only use water for needs essential to survival
- **D** consumers should use water at or below the rate of renewal of ground, surface and stored water sources

5 The phrase 'think global, act local' can be applied to the conservation of water through:

- **A** global organisations such as the UN holding events such as World Water Day
- **B** Australian government initiatives such as 'Water for the future'
- **C** national consultation with the traditional owners of the land
- **D** the implementation of water saving strategies in your own home

Short answer

1 Discuss the status of water as a renewable environmental resource.

2 Identify the ways in which water connects places as it moves through the environment. Use examples to support your answer.

3 Explain how water depletion and degradation in one place can affect the water and environment in another place. Use examples to support your answer.

4 Suggest 3 ways that the first Australians read the landscape in order to find ground and surface water. Use examples to support your answer.

5 Analyse the difference between living with the land rather than living off it. What do you think all Australians can learn about water conservation from this traditional view?

Source 1.23 This dot painting shows Aboriginal depiction of water creatures [NAA: A1500, K5959]

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Extended response

Research the potential environmental, social and economic impacts of the bottled water industry in Australia. With reference to Sources 1.15 and 1.17, assess the sustainability of the industry and present your findings in a short report.

Source 1.24 A holy man looks over the Ganges in the early morning. The Ganges provides life and livelihood to millions of Indians who live along its banks, and is considered holy by Hindus.

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2 Water in nature

Source 2.1 The Norris Geyser Basin in Yellowstone National Park, the first national park in America and the world

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Before you start

Main focus

Water is an abundant and important substance that shapes, sustains and connects all parts of nature as it cycles through the environment.

Why it's relevant to us

Its unique properties make water essential to all life on our planet and it sustains the natural environment that people constantly interact with.

Inquiry questions

- Where is water in the world?
- What properties make water so important in nature?
- How does water move through the environment and connect places on its journey?
- How does the use of water influence the sustainability of its supply?
- Why is the availability of water in Australia sometimes limited?

Key terms

- Blue water
- Green water
- Catchments
- Evaporation
- Groundwater
- Run-off
- Water cycle

Let's begin

Water is one of the most crucial compounds in existence. However, most of us take for granted the ease of turning on a tap and enjoying a seemingly endless supply of water. Water cycles through the environment in various ways, but it is only a tiny fraction of this water that is both fresh and accessible. In Australia, where the climate is variable and water is sometimes scarce, our ability to access water is crucial.

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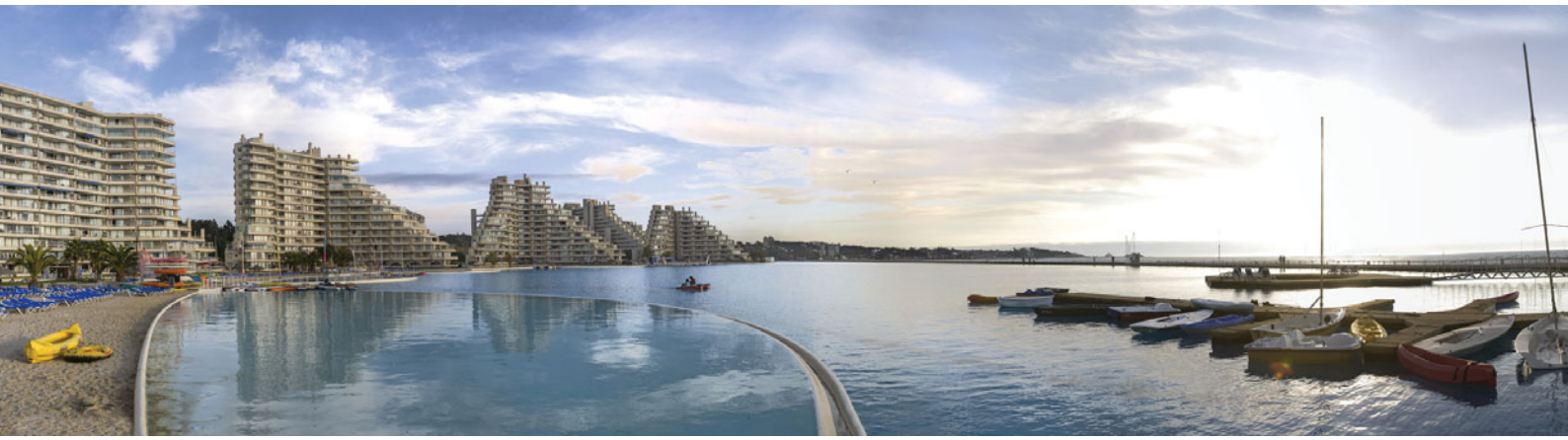
2.1 Water everywhere

> Water, water, everywhere
> Nor any drop to drink
>
> Samuel Taylor Coleridge,
> *The rime of the ancient mariner*, 1798

We live on a watery planet – about 71% of the Earth's surface is covered by ocean. At an average depth of about 1 km, this makes up a mind-boggling 1.26 billion trillion litres of water! That is roughly 504 000 billion Olympic sized swimming pools or 5000 billion times the size of the swimming pool in Source 2.2. As the poem suggests, we certainly do have water, water everywhere! However, only a tiny proportion of this water is fresh and in a suitable state for us to drink.



Source 2.2 A little slice of the Pacific: the world's biggest pool in Chile holds 250 million litres, is nearly 1 km long and draws water from the ocean.

Movement of water

atmosphere the gaseous envelope surrounding the Earth; the air

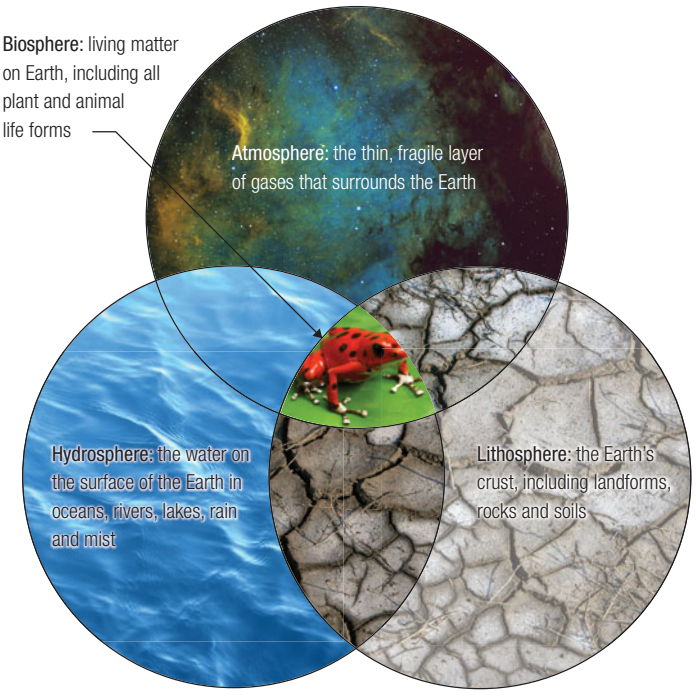
biosphere the ecosystem comprising the Earth and all living organisms that inhabit it

hydrosphere the water on or surrounding the surface of the globe, including water in the atmosphere

lithosphere the solid portion of the Earth made up of the crust and upper mantle

Water is one component that moves through each of the Earth's 4 spheres: the **atmosphere**, **hydrosphere**, **biosphere** and **lithosphere**.

We think of water normally within the hydrosphere. This is the water that we see in our oceans, rivers and lakes, as well as in dams (where water is diverted into the pipes that carry it to towns and cities and eventually into our houses where we access it with the simple turn of a tap). However, a significant amount of water is also found within the other spheres, sometimes in different physical states – for example, as water vapour in the atmosphere.



Source 2.3 The Earth's 4 spheres

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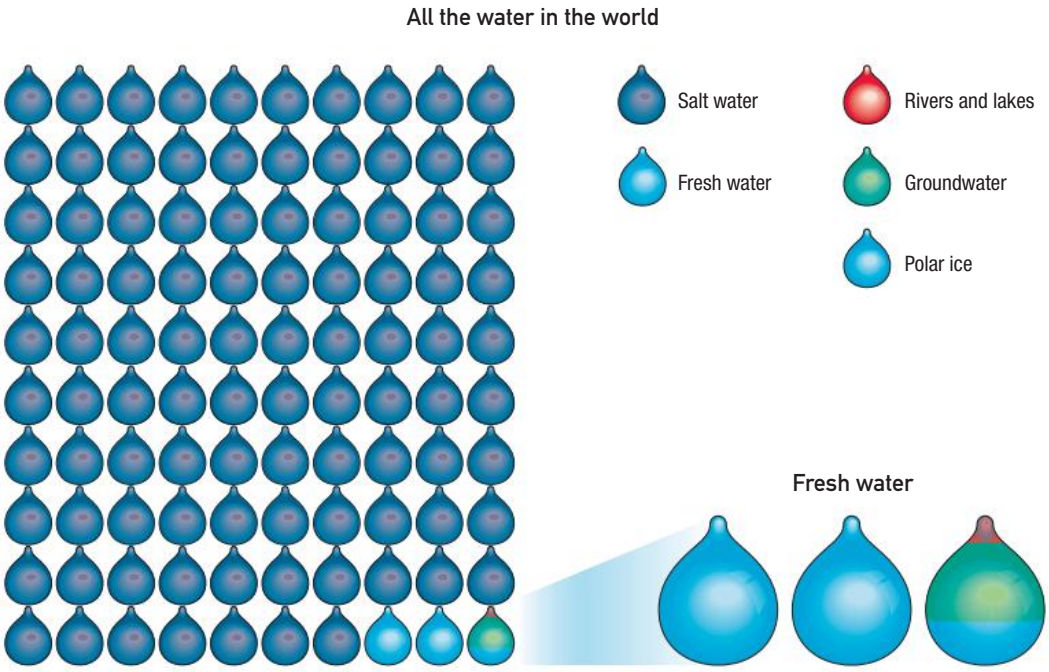
We have already heard about all the water held in our oceans. A whopping 97.2% of the Earth's water is in our salty oceans. It would solve a lot of world problems if we could simply drink ocean water – although if we were to try this, we would die of dehydration.

Geographical fact

Our kidneys can only produce urine that contains less salt than salty water. So to get rid of the excess salt taken in by drinking ocean water, you would have to urinate more water than you drink!



Source 2.4 Only a tiny fraction of the Earth's water is fresh and accessible.

water cycle the continuous cycling of water through the Earth's spheres via processes of evaporation, condensation, precipitation, run-off and infiltration

groundwater water that is located beneath the Earth's surface

The **water cycle** is constantly transferring the world's water supply between storage reservoirs in each of the Earth's spheres and in particular between the oceans, the land and the atmosphere. At any one point in time, only a tiny fraction of the Earth's water is moving through the water cycle. Of the remaining 2.8% of water not stored in the oceans, a significant 75% is locked away in glaciers and ice sheets. Another 24% of this small fraction is in **groundwater**, which may be in underground reservoirs or in soil moisture (**green water**). Rivers and lakes, where we access most of our drinking water, contain a tiny 0.009% of all water on Earth.

green water moisture in the soil

The rest of the water on the planet is either floating in the atmosphere or is contained in plants and animals. (Our bodies are approximately 65% water.) Also, imagine how many litres of water are sitting in our refrigerators and kitchen shelves in bottles of drink and foods that contain water.

One of the biggest issues in the world is that water distribution is not equal over the Earth. Rainfall across continents, and even across

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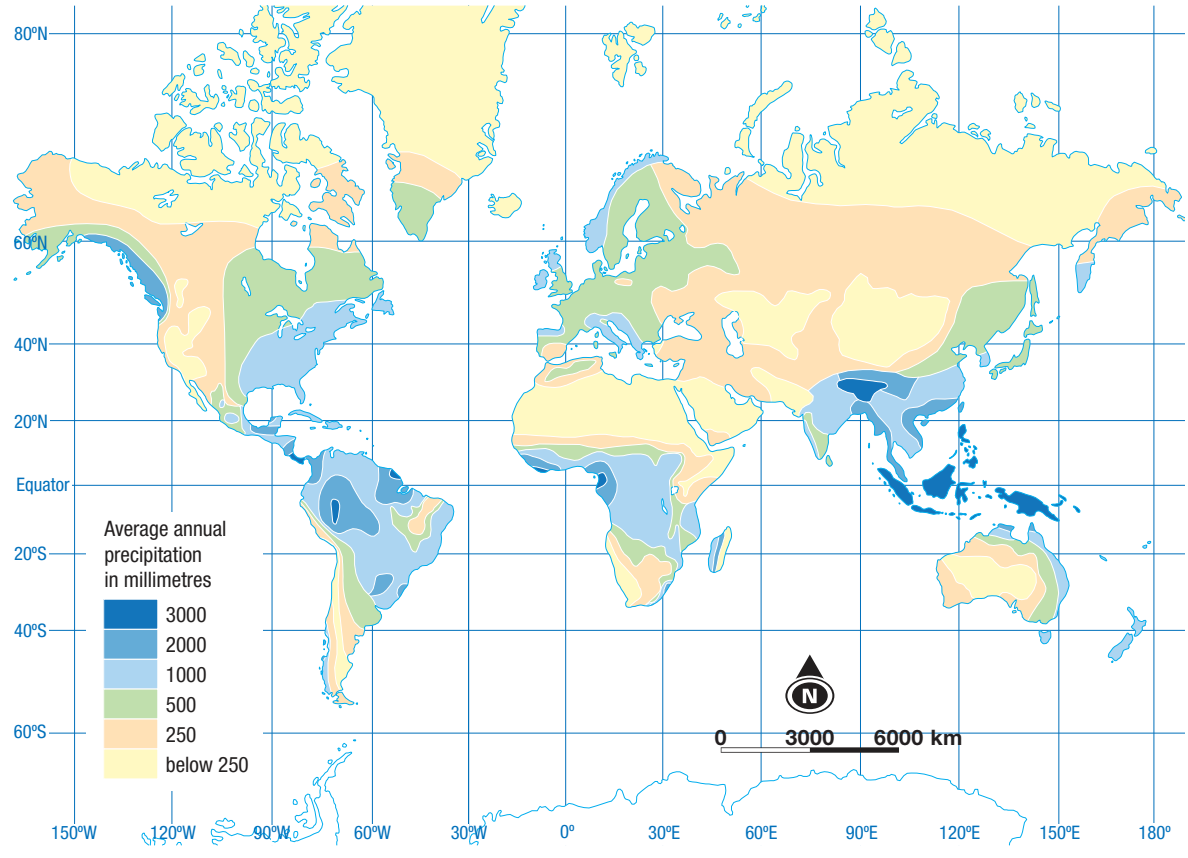
Source 2.5 The spectacular blue ice of Lake Fryxell: located in Antarctica, the freshwater lake is 4.5 km long and, like much of the continent, is covered by a thick layer of ice for almost the entire year.

countries, is uneven and often inconsistent. Every continent (except Antarctica) has regions of high rainfall and regions of low rainfall. For example, parts of central western Africa receive over 2000 mm of annual **precipitation**, whereas the Sahara desert to the north receives less than 250 mm.

precipitation water that falls from clouds and may be in the form of rain, hail, snow or sleet



Source 2.6 The average amount of rain that falls around the world each year

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ACTIVITY 2.1

1 List the sphere that water is located in for the following situations:
   - **a** groundwater
   - **b** water vapour evaporated into the air
   - **c** water travelling through a river
   - **d** water being taken up by a tree.

2 Construct a diagram showing the movement of water through the 4 spheres.

3 Explain why water is not always easily available even though it is so abundant.

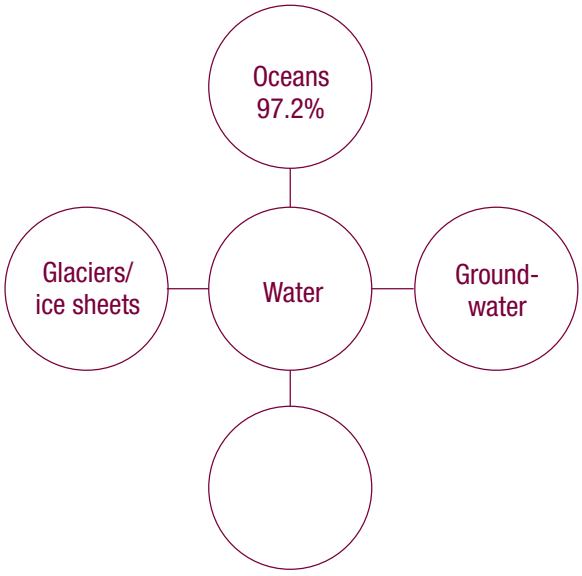
RESEARCH 2.1

In small groups, research reasons why there are significant differences in rainfall between different regions of either China or the USA. For example, you could compare the south-eastern region to the north-western region of China. Consider differences in altitude (e.g. location of mountain ranges), temperature and climate events such as summer monsoons. There are links to websites that will help you with this task at www.cambridge.edu.au/geography7weblinks.

Produce a report articulating these differences in the country you choose. Included in your report should be a map of rainfall in that country and descriptions of why differences in rainfall exist between the different regions.

NOTE THIS DOWN

Copy the graphic organiser and indicate where and how much water is located in different parts of the Earth.



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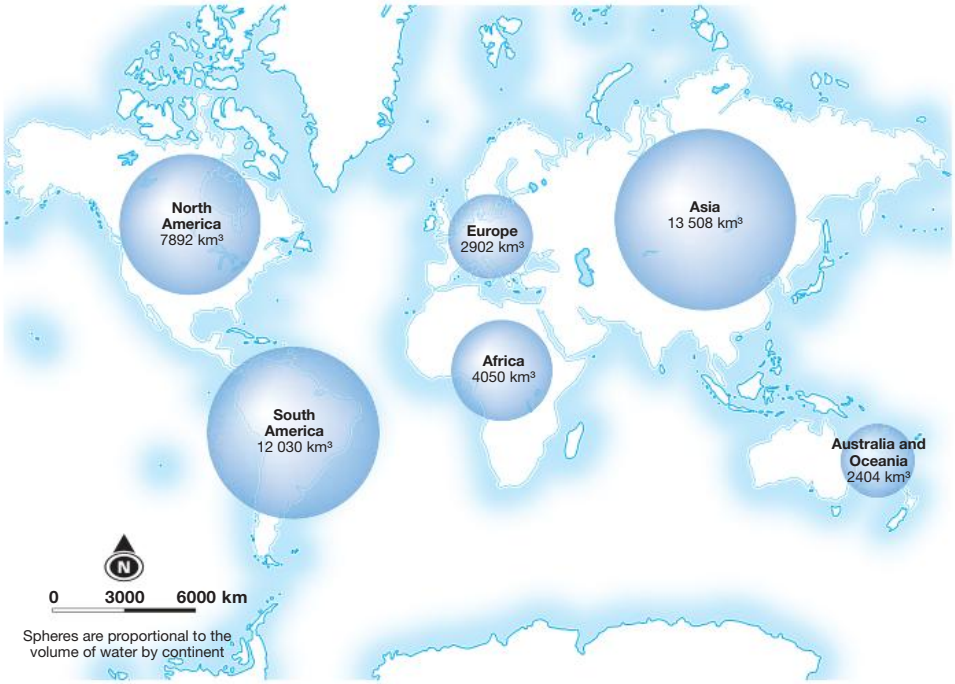
2.2 Water for life

The water molecule is essential for life. This simple molecule, made up of 2 atoms of hydrogen and 1 atom of oxygen, has amazing properties.

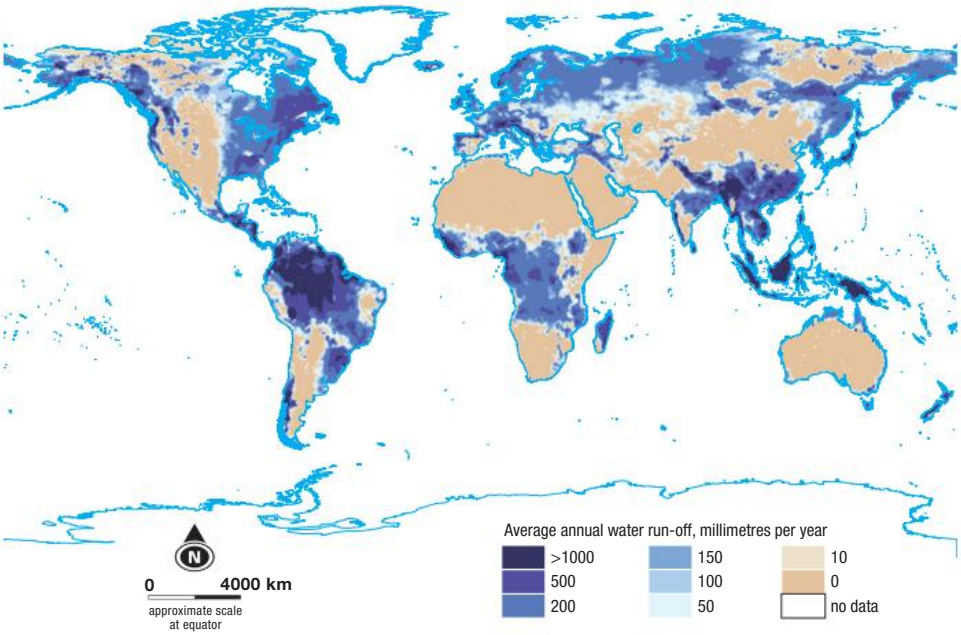
run-off water (from precipitation) that flows over the land and collects in rivers, lakes, seas and oceans

Where rain falls is crucial to the existence of life on Earth. More important than this, however, is **run-off**. Although all rain makes its way to the ground, a number of factors determine how much of this rain actually makes its way into rivers and lakes, where humans source nearly all of their water. One of these factors is **evaporation** – in Australia, for example, only a small proportion of the rain that falls actually runs off the land into our river systems, due in large part to very high evaporation rates.

evaporation the part of the water cycle where water changes from a liquid into a gas and escapes into the atmosphere



Source 2.7 Average annual run-off by continent and volume



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Source 2.7 shows the average volume of annual run-off by continent. It is important to note that the size of the continent will significantly affect run-off amounts, although comparing Australia and Asia, for example, will reveal significant differences in water availability.

As for rainfall and run-off, the Earth's major river systems are unevenly distributed. Source 2.8 shows the location of the world's largest and most important rivers. Comparing this map with the average rainfall map (Source 2.6), you see that the locations of rivers do not always correspond with areas of high rainfall. For example, a number of significant rivers, such as the Ob River in Siberia, flow through northern parts of Europe, where the annual average rainfall is very low (approximately 250 mm or below). When we consider the second illustration in Source 2.7, we notice that this region has a reasonable volume of annual run-off. How can this be? This is a region of substantial ice melt during warmer months, where arctic glaciers and ice caps grow and then melt on a yearly basis.

Source 2.8 Major rivers of the world

Geographical fact

Did you know that Antarctica is actually a desert? It is the driest continent on Earth with virtually no rainfall. (The only precipitation falls as snow – on average 166 mm per year.)

Properties of water

Water is the only substance that can be commonly found on our planet in 3 different states – as a solid, a liquid and a gas – each of which is crucial to life on Earth. Water is known as a polar substance, which means that it has 2 different charges, like batteries. The hydrogen atoms of water give the molecule a slight positive charge, while the oxygen provides a slightly negative charge. Most elements and molecules (chemical substances) found on Earth tend to have a preference to bond to (join up with) either positive or negative substances. The bipolar structure of water enables all sorts of substances (regardless of their charge preference) to attach to water molecules and then dissolve in them. This means that water in the oceans, rivers, lakes and even in our drinking water contains all sorts of substances (e.g. sodium chloride or table

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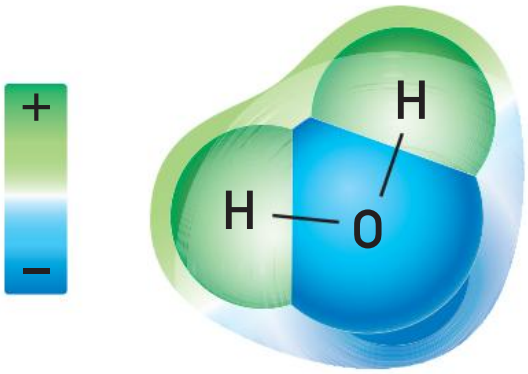

Source 2.9 Water – a molecule for life

salt) that are crucial for the survival of plant and animal life.

Our oceans have, on average, approximately 5 teaspoons of salt for every litre of water (or 35 g in every 1000 g). This may not sound like a lot, but it would take around three 6 m long shipping containers full of salt to make an Olympic-size swimming pool as salty as the sea. This amount of salt enables seawater to become denser, and as a result the ocean needs to be colder than freshwater before it freezes. If this were not the case, we would be potentially in a constant ice age – even off the coast of Australia. Instead of a surf break you could be catching an ice break!

When water freezes, it also expands and so becomes lighter and floats. Have you ever seen an ice block sink to the bottom of your glass of soft drink? I doubt it! Imagine if ice did not float – in cold oceans the sea would freeze, along with everything in it. Thankfully, the ice shelves over the poles insulate the water below and stop it from freezing as well.

Another crucial property of water is its ability to absorb heat. Picture walking to the beach on a really hot day. You reach the sand and you're desperate to get to the water. You take your thongs off, but the sand is so hot it almost burns your feet. You run, forgetting everything else, until at last you reach the nice, cool, soothing water. Have you ever thought of why the sand is hot, but the water is cool even though the heat from the sun reaching both is exactly the same? It is because the chemical bonds between water molecules can absorb a lot of heat without causing the water itself to change in temperature much, whereas the sand reflects much of the heat back into the environment.

Capillary action gives water the ability to travel through pipes or other containers. Water molecules stick together as well as to surrounding surfaces, enabling water in the liquid state to travel against gravity. This is important in nature, particularly in the case of plants, where the ability to take up water is crucial, as well as in human applications like houses, where water may need to be piped to different storeys. There are so many other amazing properties of this truly unique molecule, but too many to discuss here and now.

Source 2.10 If ice did not float, we could end up like this fox.

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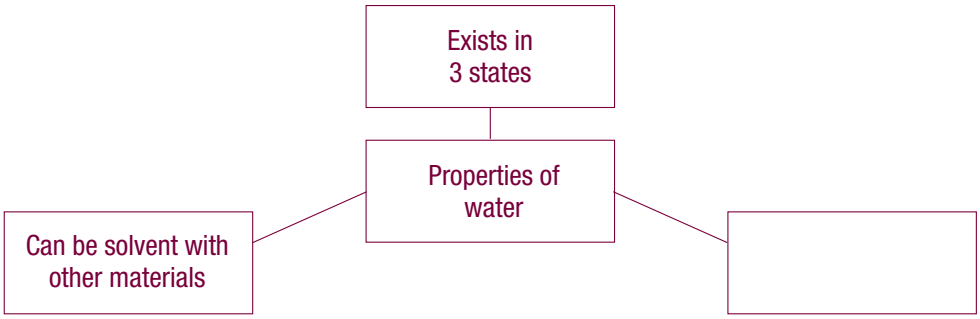
NOTE THIS DOWN

Copy the graphic organiser below and explore different properties of water and the role that these properties play in sustaining nature.



ACTIVITY 2.2

1. Explain in your own words what 'run-off' means.
2. Compare the map of average annual run-off (Source 2.7) to the map of rainfall (Source 2.6). How well do these 2 characteristics generally compare across the Earth – for example, do areas of higher rainfall normally correlate with areas of higher run-off?
3. Using the data from Source 2.7, suggest why Europe has a much lower average volume of run-off than some continents.
4. Locate the following rivers in an atlas or on an online map:
   - **a** Amazon
   - **b** Mekong
   - **c** Nile
   - **d** Rhine
5. Explain why the ocean does not completely freeze over near the poles.

RESEARCH 2.2

In pairs, research in detail *1 or more* of the important properties or characteristics of water covered in this chapter. For example, you could investigate more about water's role as a universal solvent (its ability to dissolve most substances on Earth), its status as the only substance commonly found on Earth in all 3 states (solid, liquid and gas) or the ocean's ability to moderate the Earth's climate.

Produce a poster advertising water to aliens on another planet. Include on the poster pictures and descriptions that show how crucial water is to life on Earth. Create an advertising slogan (e.g. 'Water – life's miracle molecule'). You will find links to useful websites to help with this task at www.cambridge.edu.au/geography7weblinks.

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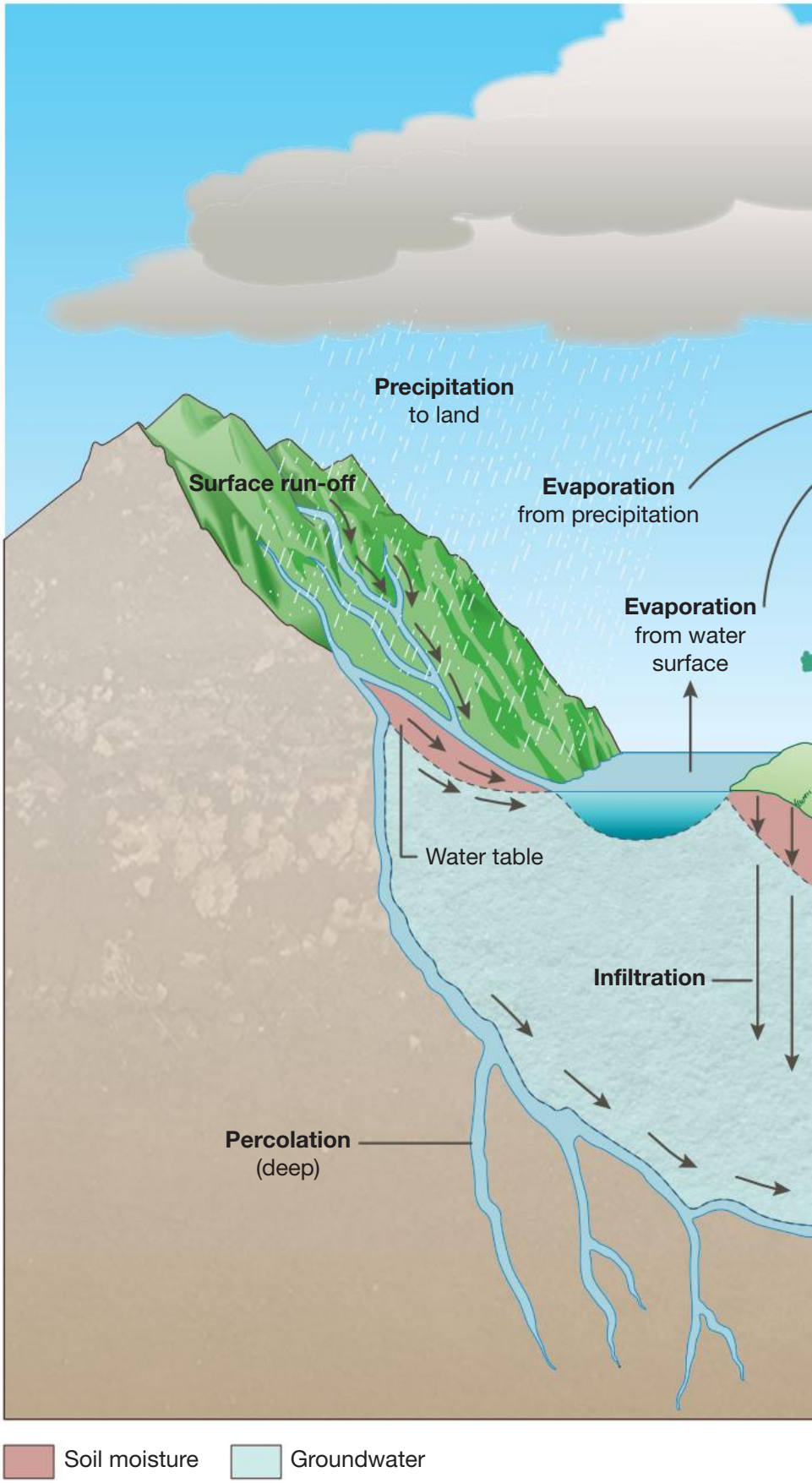
2.3 The water cycle

Although much water on Earth is locked away for a time – for example, in ice sheets or underground – people are most interested in the water that is constantly on the move through the environment, connecting different spheres and locations together as well as shaping the landscape around us. We have already learned a little about one of the water cycle's key processes – run-off. Now let's learn a bit more about the journey of water.



Source 2.11 The water cycle

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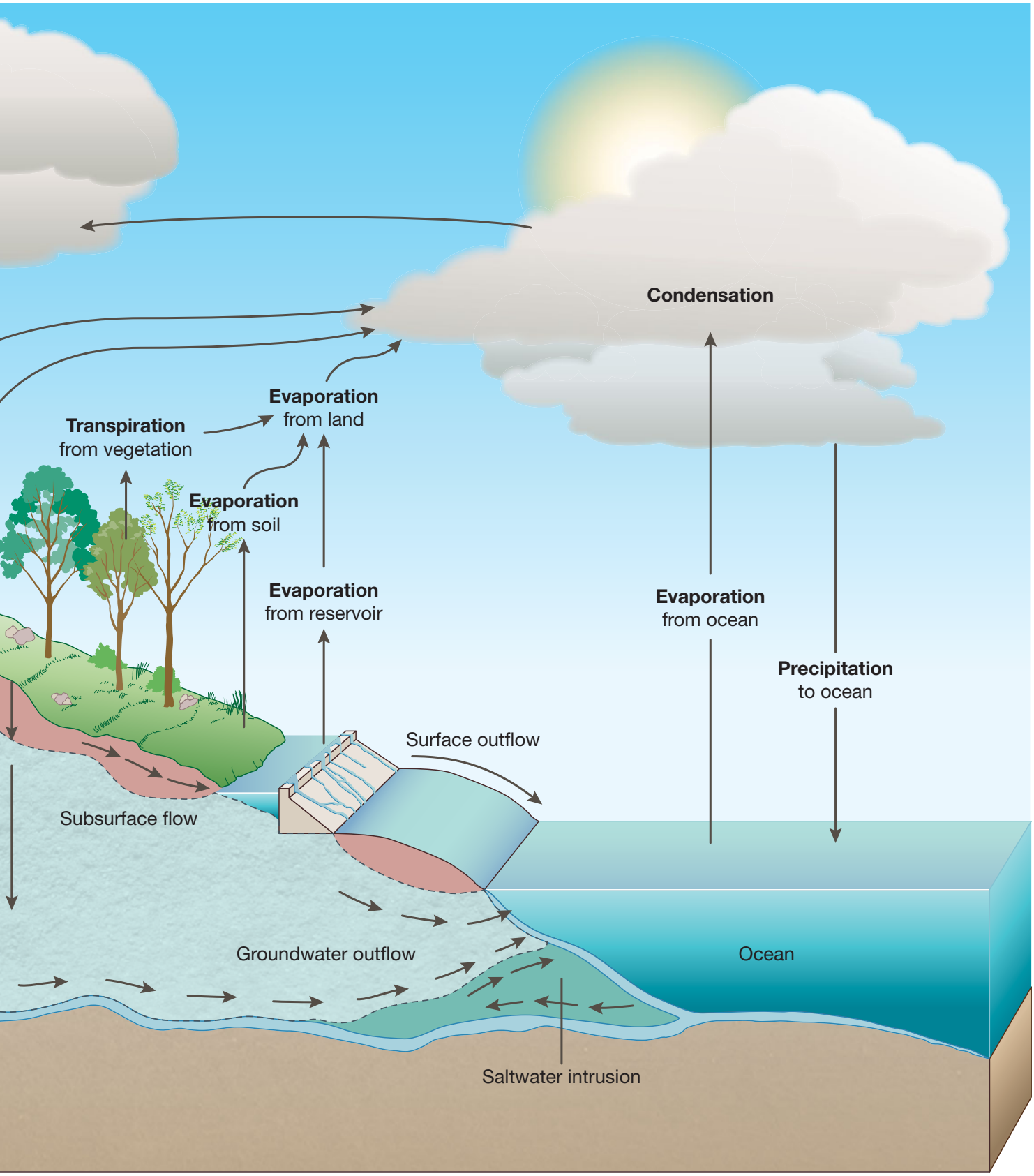

Ocean covers 71% of Earth's surface or 196 950 000 sq miles (510 000 000 sq km).

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Most of the evaporation that essentially kick-starts the water cycle occurs over oceans, where water is transferred from the hydrosphere to the atmosphere. Weather and climate patterns influence evaporation rates. For example, ocean temperatures differ significantly throughout the Earth – where there are warmer ocean currents there is more evaporation, since it requires less heat from the sun to increase the water temperature to a point where it changes from liquid to water vapour.

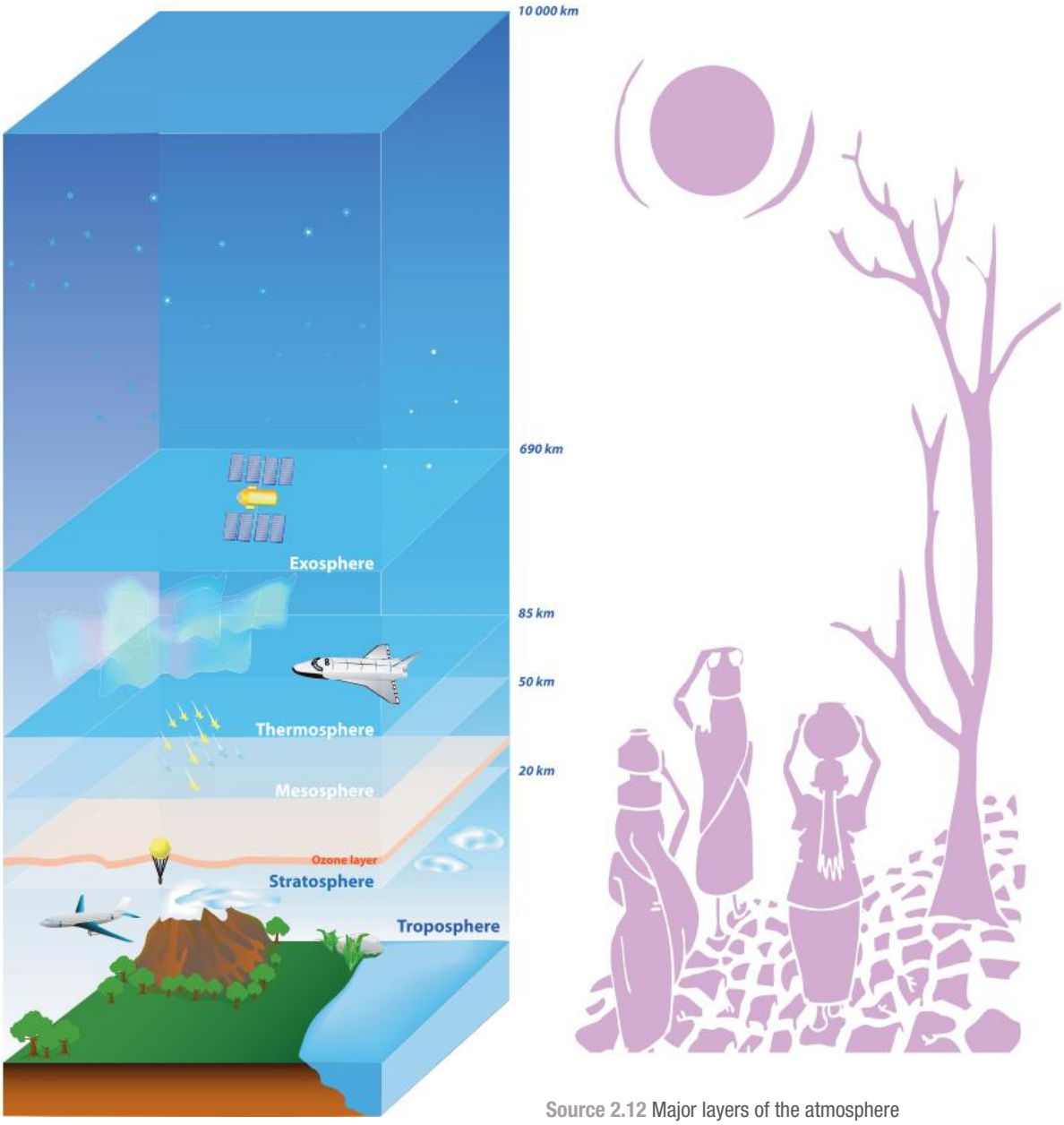
Water also moves from the lithosphere (in the soil) to the atmosphere, usually via trees and plants (i.e. the biosphere). Water moisture in the soil may be referred to as 'green' water, as opposed to freshwater (e.g. surface water or **blue water**) in lakes and rivers, or underground **aquifers**. This green water travels up through the soil via plant roots, then through the capillary action of water it moves up through the plant to the leaves, where the heat surrounding the leaves causes water to evaporate into the air – this whole process is referred to as **evapotranspiration**. As humans, we also **transpire** as we sweat, with water being

blue water freshwater in lakes or rivers

aquifer geological formations containing groundwater that can supply water to wells or springs

evapotranspiration the process whereby water is released into the atmosphere through evaporation and the transpiration of plants

transpire to absorb and release heat as water evaporates from plant leaves or animal skin (thereby cooling the plant or animal)



Source 2.12 Major layers of the atmosphere

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transferred from liquid to water vapour in the external environment. In this way we release heat that has been previously stored between water molecules. Essentially, 'evapotranspiration' means evaporation is driving this transpiration process.

Water turns from liquid to gas through the process of evaporation, and the opposite occurs when temperatures drop in the atmosphere. The atmosphere is made up of 4 main layers, all varying in their amount and composition of gases. As you go up in height, the air gets colder. The **troposphere** is where the weather occurs. In the upper parts of the troposphere, the temperature drops to a point where water molecules slow down and join together as they collide, through the process of **condensation**. As condensation occurs, clouds begin to form, carrying the water that will eventually become rain.

troposphere the atmospheric layer closest to the ground, containing 99% of the atmosphere's water vapour

condensation the process whereby water molecules join together and so change the water from a gaseous to a liquid state

Precipitation occurs when water falls to the Earth's surface, and it may take the form of rain, hail or snow. Rainfall is the most common form of precipitation; it usually occurs when clouds or water vapour travel from warmer air to cooler air. As the air cools, water droplets become heavier and the air reaches a point where it is unable to hold the moisture, and thus the water falls as rain. Such changes in air temperature may have different causes depending on the climate and on factors such as ocean conditions and the **topography**. Later in this chapter, we will learn more about different causes of rainfall.

topography the shape of the land

Once the rain has fallen, it either runs off the land or infiltrates the soil or groundwater aquifers. Much water that enters the groundwater system still makes its way back to the ocean through groundwater flow.

The amount of run-off or **infiltration** that occurs is influenced by the soil type; for example, loose sandy soils allow rainfall to sink through the ground easily, whereas clay soils form a barrier and more water runs off the land. Plant cover also contributes to this, since plants intercept and soak up water and may therefore reduce run-off. However, the most important factor in determining how much run-off occurs is the amount and regularity of rainfall. One large downpour of rain will not produce as much run-off as consistent rainfall. Once soil becomes soaked and is unable to soak up more

infiltration the process by which water on the ground surface soaks into the soil

Source 2.13 The Noosa everglades on the Sunshine Coast, Queensland. The constant mixing of water from the Coral Sea and the Noosa River create a beautiful environment with a variety of flora and fauna including mangroves, turtles, dugongs and dolphins.

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water, any additional rainfall is able to run off into rivers or lakes. As we will learn later, this is why in Australia run-off is highest in northern regions, where the climate is tropical and rainfall is heavier and often more consistent.

While humans and animals rely directly on freshwater, 'green' water that infiltrates the soil is crucial to plants, crops and the habitats of many creatures. Whereas we refer to water in the ocean as salty or saline, this 'green' water is often classified as brackish, meaning it is slightly salty. Other locations where **brackish water** is common are in **intertidal zones** or **estuaries**. Estuaries are important environments where this brackish water combines with tidal changes to create unique ecosystems. To survive in these conditions, plants and animals living in estuaries must be able to respond quickly to drastic changes in **salinity**. For example, during low tides when they are exposed to low-salinity water, oysters close up their shells and stop feeding. Isolated in their shells, they switch their breathing to a method that does not require oxygen. When high tides return and the salinity and oxygen levels in the water are much higher, the oysters open their shells and return to feeding and breathing oxygen.

brackish water water that absorbs salts from the soil but has a lower salt content than seawater

intertidal zone the area at the edge of a body of water (e.g. the ocean) that is exposed at low tide and under water at high tide

estuaries bodies of water formed where freshwater from rivers and streams flows into the ocean, mixing with the seawater

salinity the salt content of water

Another example of impressive adaptation to this ever-changing environment is **mangrove trees**. Mangroves are fascinating trees that avoid competition with other plants by living in locations where most plants cannot survive. Some mangrove species have special salt glands that enable them to quickly pass the salt out of their systems once it has entered. Some mangrove roots contain a waxy substance that helps keep salt out. Because there is little oxygen in the estuary, many mangroves raise part of their roots above the surface. These roots are covered in special breathing cells that draw in air.

mangrove tree a type of tree with unique features that enable it to grow in intertidal zones or estuaries

Source 2.14 Mangroves on Cape Tribulation. Australia has the third largest area of mangroves in the world after Indonesia and Brazil, totalling around 11 500 km^2.

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Geographical fact

The troposphere contains approximately 99% of the water vapour in the atmosphere. So above the troposphere is almost completely devoid of water.

Water through a catchment

As we learned earlier, evaporation is a significant cause of low run-off rates in Australia. High evaporation rates are due mainly to the dry heat of the Australian interior, although the fact that it is also a relatively flat country does not help – this means that water flows slowly over the landscape and often evaporates before it has the chance to reach a stream or river.

Rivers are a part of a larger system of **catchments** (or drainage basins). Changes in topography mean that water enters different catchments depending on where it falls. Catchments are often separated from each other by a physical barrier, such as a ridge or mountain. The total catchment area of a major river like the Amazon includes all the **tributaries** that flow into it.

catchment (or drainage basin) the total area where water from precipitation collects and drains downhill into a body of water such as a river, lake or ocean

tributaries smaller rivers that flow into larger rivers

river mouth the end of the river system where water exits into a sea or lake

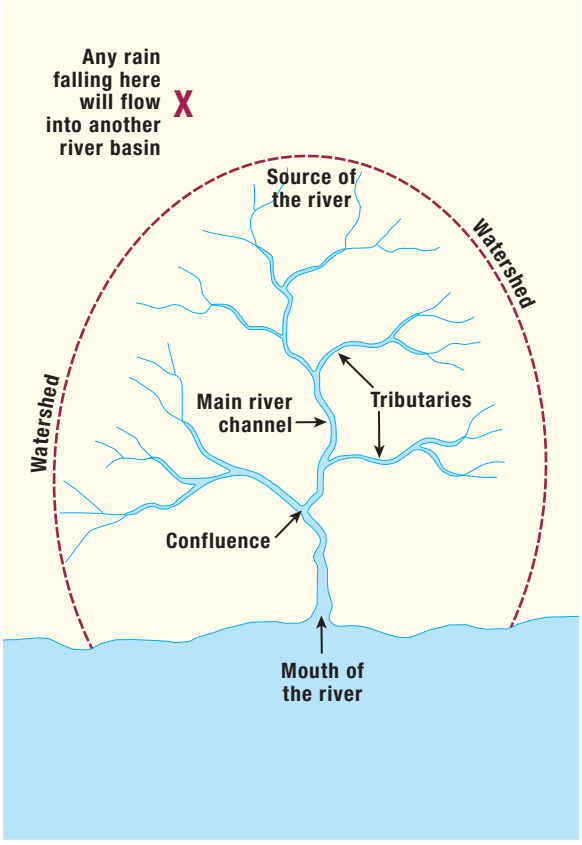
Following rainfall, a significant amount of water can be collected and drained through a river system. Points at which rivers and tributaries begin – their sources – are commonly higher up in the landscape. From there, water travels downhill by the power of gravity until it reaches the **river mouth**.

As water journeys along a river, it carves out the landscape through different processes. Everywhere we look today in nature, the landscape has been shaped by wind and more significantly by water. Rocks along the surface of river beds are broken down and carried away by the processes of **weathering**, **erosion** and **transportation**. Weathering is essentially the loosening of rocks by atmo-spheric conditions (e.g. by heat or water) or by chemicals (such as the chemicals produced by

weathering the loosening of rocks by chemical or physical processes

erosion the wearing away of the surface of the Earth by the action of wind and water

transportation the process of moving along sediments (rock materials and soil) by water or wind



Source 2.15 An individual catchment

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biological organisms like fungi, or found in the atmosphere). This loosened rock material may then be broken down further by erosion. Unlike weathering, erosion involves the movement of material. The force of water as it travels with gravity downhill is enough to remove some rock material from its location (**hydraulic erosion**), while rocks and sediments carried by the river also wear away and erode the river bed (**abrasion**).

hydraulic erosion erosion caused by the power of water and gravity

abrasion erosion caused by rocks that are carried along by water

deposition the laying down of sediments that have been transported by water or wind

Finally, material that has been weathered and eroded can be transported along the river until there is not enough energy left to carry it any longer and **deposition** occurs. At this point, the sediments drop to the bottom and are deposited on the river bed. The distance sediments travel depends on both the speed of the river and the size of the sediments, although most of the transported material is deposited near the river mouth where the slope is very gradual. One key point here is that the sediments created by broken-down rock material are combined with organic (biological) material to create soil. Next year, we will be learning a lot more about soils, landscapes and the processes that shape them. Soils are not only crucial for the environment but also for farming, an important human activity upon which civilisation depends. While 'blue' surface water is where we access our drinking water, it is the 'green' water held in soils that supports most of the world's food production.

ACTIVITY 2.3

1 With a partner, cut out 16 cards. On one side of the cards, write the key terms listed below:

hydraulic erosion	condensation	tributary	topography
precipitation	river source	abrasion	run-off
weathering	deposition	catchment	river valley
sediments	river mouth	evaporation	river delta

On the other side of the cards, write your own definitions for the terms. Test your knowledge of these terms with your partner by randomly selecting cards. You might even like to join up with another pair and play a game of Pictionary with the cards.

2 Explain the difference between 'blue' water and 'green' water.

3 A home owner intends to dig a bore (hole) into the ground so that they can access the groundwater below to use on their gardens. The home owner thinks that this is not going to have an effect on the water cycle. Discuss in small groups whether you think the home owner is right or wrong. Justify your decision to the class.

4 Cape Agulhas is the southernmost point of Africa. Refer to an atlas or research online to find out why this place experiences different ocean temperatures on either side. Explain how this difference might affect where most of the rain comes from at this location.

2.4 Water in Australia

As we have already seen, it is not just the location of water that is important, but also the amount. Source 2.16 shows the 4 largest rivers in the world based on the volume of water that exits the river system as each enters its river mouth. Also included is the Murray–Darling – Australia's largest and most important river system.

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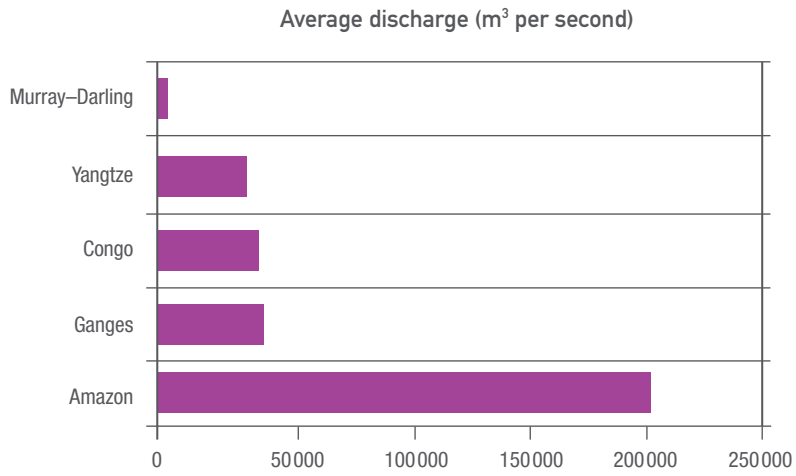

Source 2.16 Average discharge of water from some of the world's major river systems and the Murray–Darling system

The 209 000 cubic metres of water that exits the Amazon River per second accounts for nearly one-fifth of all the freshwater that drains into the oceans of the world, and yet the Amazon River basin is currently accessible to just 25 million people (0.4% of the world's population). So much water pours out of the Amazon that the salt content and colour of the Atlantic Ocean are altered for a distance of about 320 km from the mouth of the river.

cubic metre the volume of a cube with its edges 1 m in length (equal to 1000 litres)

Compare this to the Murray–Darling river system, where only 391 **cubic metres** of water exit per second. As we shall see in the next chapter, the Murray–Darling river basin is our most important farming region, producing around one-third of Australia's food supply. Despite our reliance on this river system, the amount of water that travels through it is very small on a global scale. To put the volume of water the Amazon carries in perspective, the Murray–Darling's length is more than the Amazon's (3370 km compared to the Amazon's 6400 km) and yet the Murray–Darling discharges less than 0.2% of the water that the Amazon discharges! So why such a difference? Let's find out.

Source 2.17 The mighty Amazon River

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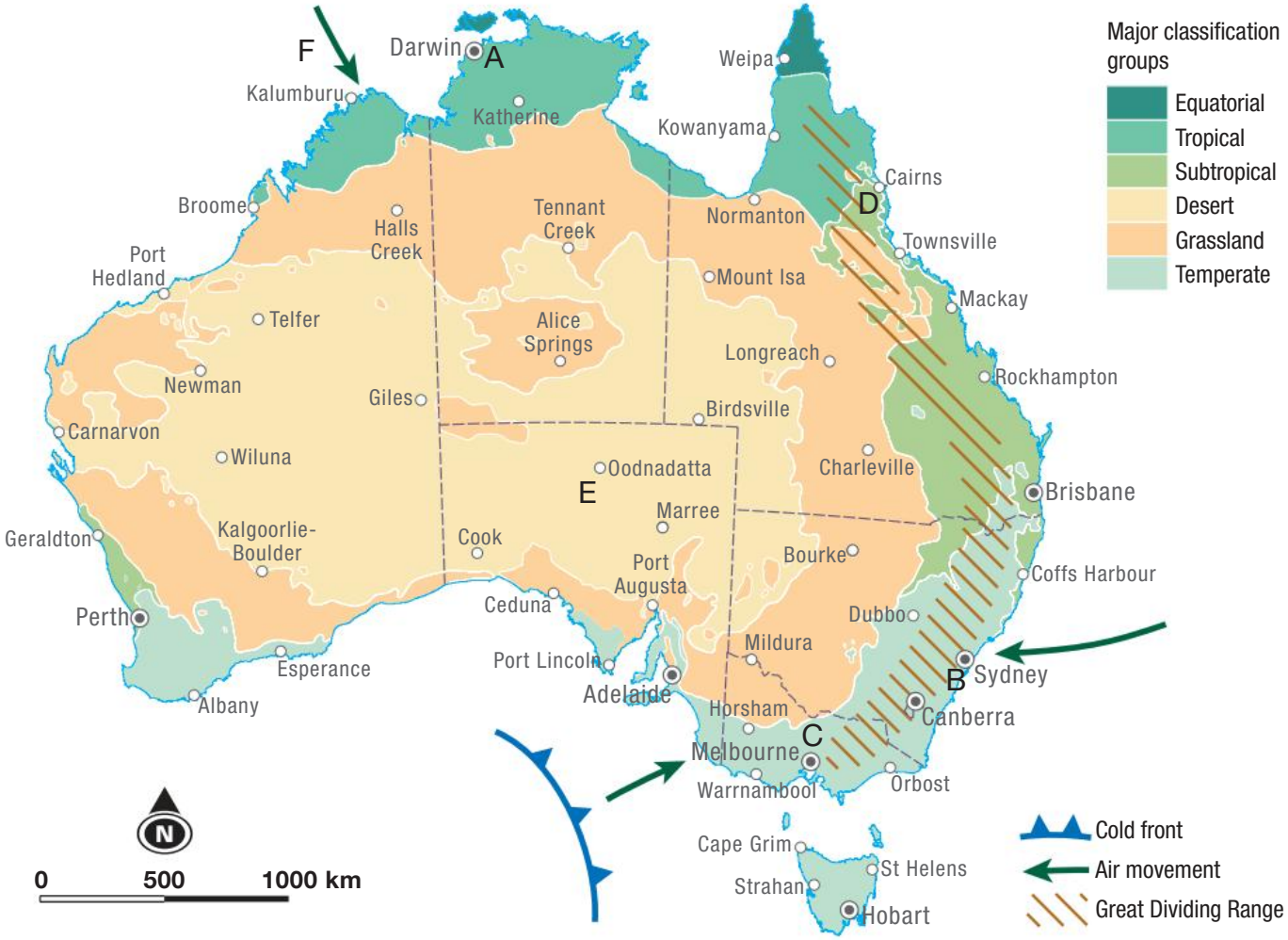
Climate and rainfall



Source 2.18 Climate types in Australia (see the text for detail about the letters on the map)

Australia is such a large country and, as such, it has a climate that varies considerably. Rainfall and temperatures differ significantly between the north and south of the country, as well as between coastal areas and inland regions. Let's explore reasons for some of these differences. The following letters correspond to those found in Source 2.18.

A: Convectional rainfall

The northern coastline of Australia is located relatively close to the Equator. Darwin, for instance, is just 12.5° south of the **Equator**. This region receives relatively direct sunlight all year round.

Equator the zero degree line of latitude that circles the middle of the Earth

All rainfall requires a cooling in air temperature. As the heat from the direct sunlight hits the Earth in this region, the warm air is drawn upwards and cools. There is also much moisture in this air, as the heat near the Equator produces high evaporation rates. As the warm moist air cools, at over 150 m **altitude** rain falls.

altitude the height of land above sea level

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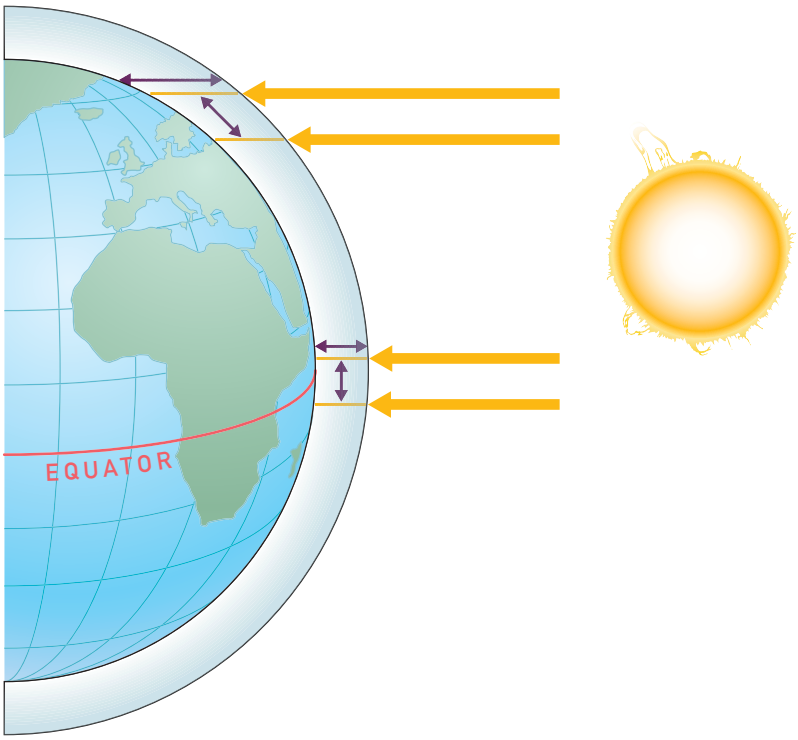
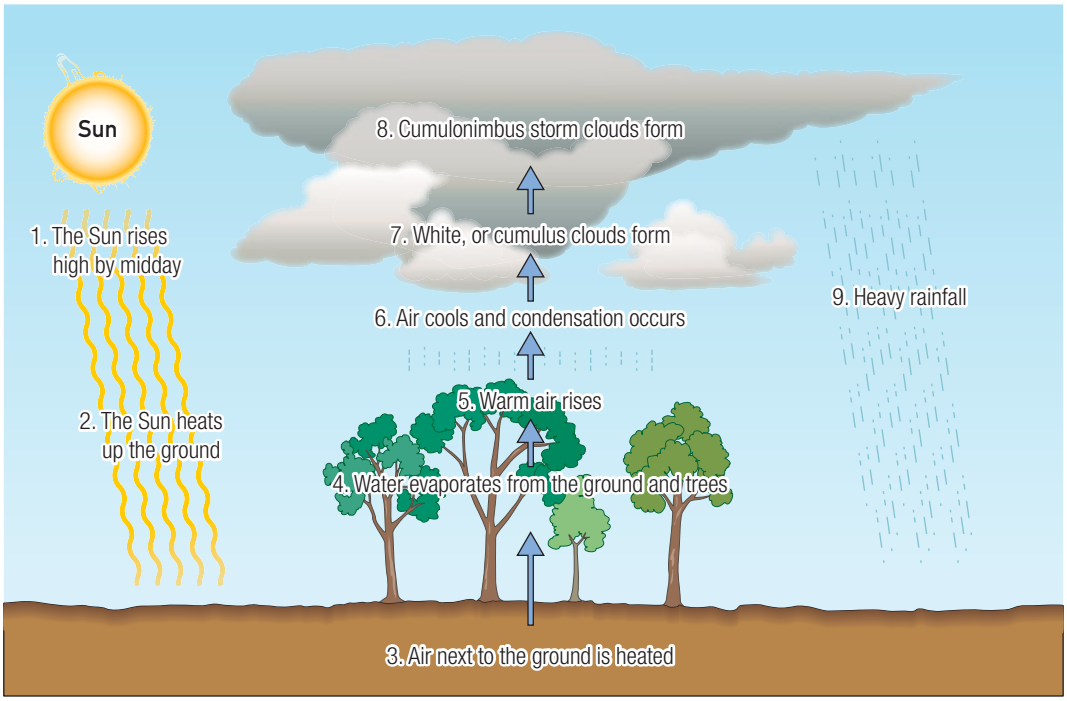


Source 2.19 Sunlight hits the Equator and tropics most directly. As sunlight reaches closer to the poles, it hits the Earth's surface on a much larger angle and thus at a reduced energy level.



Source 2.20 Convectional rainfall formation, common in tropical regions

B: Orographic rainfall

The Great Dividing Range is Australia's largest mountain range, stretching for more than 3500 km from north-eastern Queensland and running close to the eastern coastline all the way to the central Victorian highlands. Easterly winds (carrying evaporated water vapour) move inland from the Pacific Ocean and travel over the coastal plains along the east coast before reaching the Great Dividing Range. The sharp rise in altitude forces the moist air upwards and causes it to quickly cool, causing rainfall over mountain ranges. This type of rainfall is known as **orographic**.

orographic rainfall rainfall that is caused when masses of air containing water vapour are forced upwards by physical features such as mountain ranges

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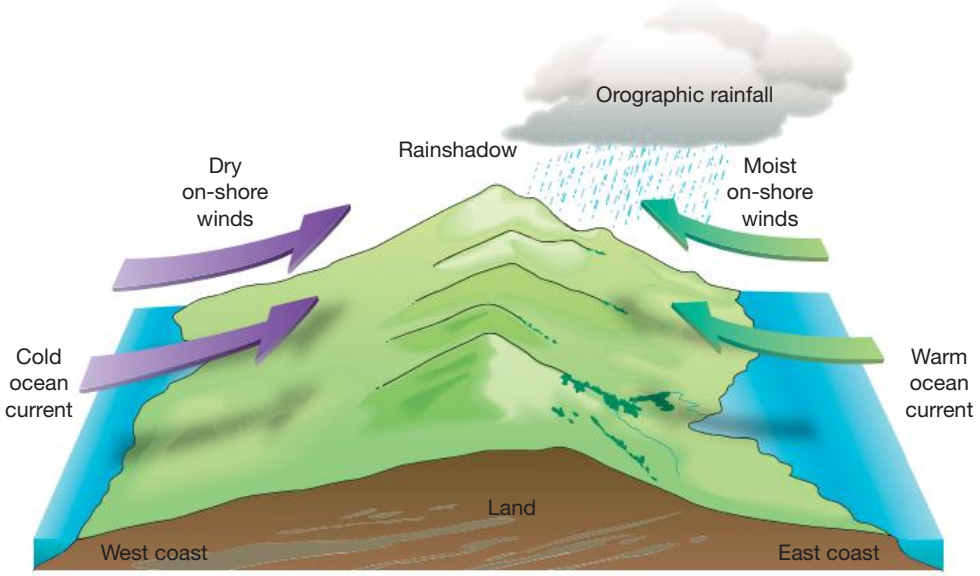
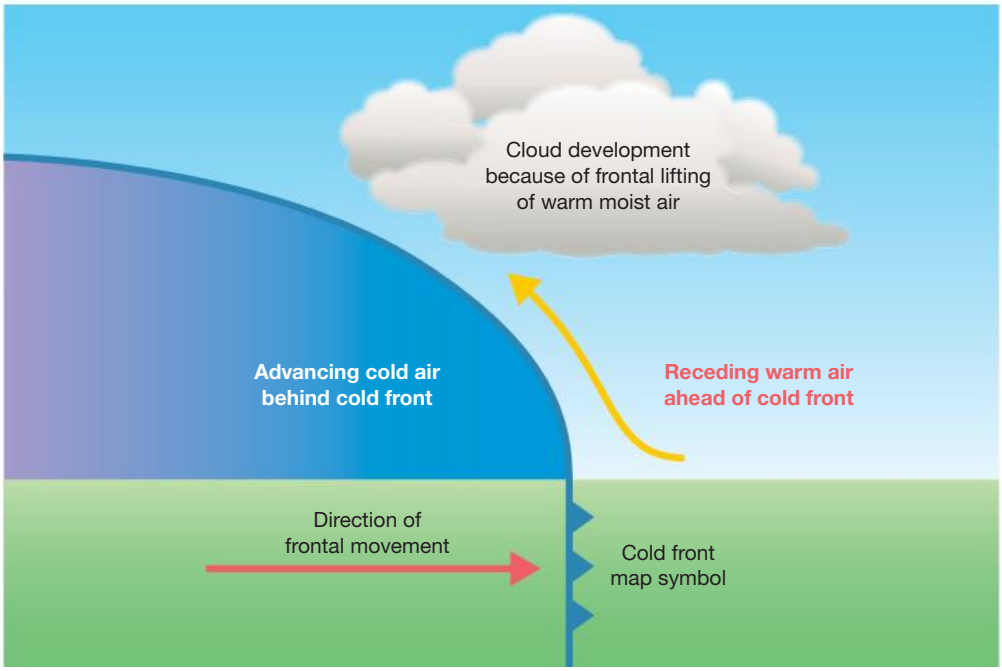
Most of this rain falls on the eastern side of the ranges and runs off in the direction of the ocean. As the air continues over the ranges and then inland, it loses most of its moisture – this is why inland Australia is so dry. The air that moves towards the western coastline, from the Indian Ocean, is already dry due to the lower rate of evaporation from the colder ocean currents.



Source 2.21 Simplified cross-section from east to west across the continent, showing rainfall on the eastern side of the Great Dividing Range

C: Cold fronts

Have you ever experienced a cold front? If you have been outside on a sunny day, when the weather suddenly turns chilly, the wind picks up and clouds seem to appear out of nowhere, then you have. In the south-eastern region of Australia, and to an extent the south-western corner, cold fronts are common. These weather systems are basically cold air moving northward from Antarctica. As the cold air moves over land, it pushes underneath the warmer air. The warmer air is forced upwards and cools, so that it is unable to hold its moisture any longer and it falls as rain.



Source 2.22 A cold front; warmer air is forced above the mass of moving cold air, causing rain clouds to form.

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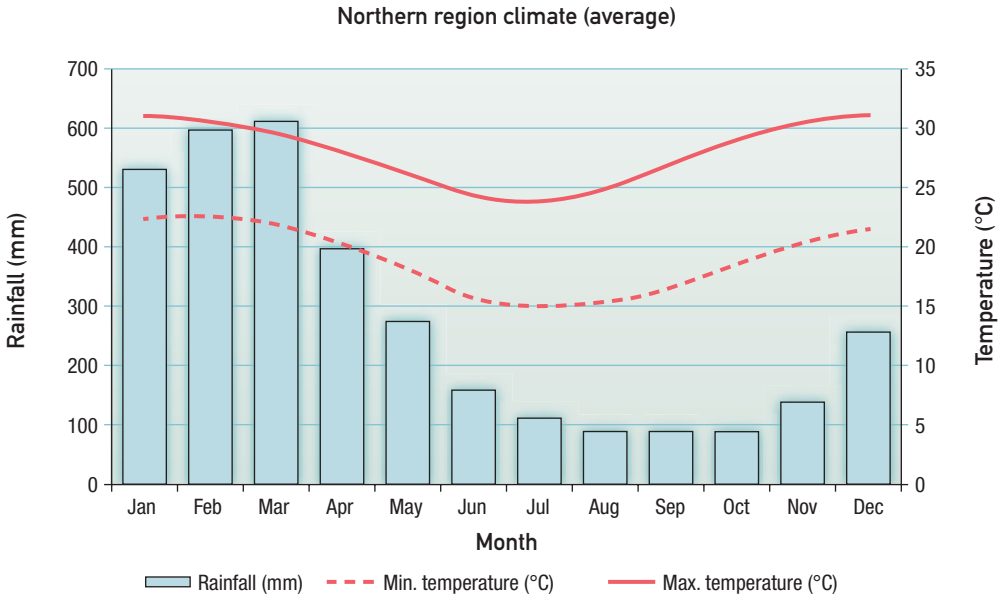
D: Australia's wettest town

The north-eastern Queensland agricultural region around Cairns receives on average over 3200 mm of rainfall a year. Compare this to the Australia-wide average of 464 mm per year, which is very low on a global scale. Tully, located just 140 km south of Cairns, was awarded the 'Golden Gumboot' as Australia's wettest town. The average rainfall in Tully is approximately 4490 mm a year! Not only does it receive a huge amount of rain, but the rain is also very consistent, with 150 days experiencing rainfall per year on average. Tully receives this much rain due to its location in the wet tropics, where cyclones and monsoonal rain can develop. The town is also situated alongside mountain ranges that attract rain clouds from across the Coral Sea. Thus Tully receives a combination of orographic and **convectional rainfall**.

convectional rainfall
rainfall that is caused when air containing water vapour is drawn upwards due to heating of the Earth's surface (e.g. in tropical regions)



Source 2.23 Climate of the northern agricultural region around Cairns

Source 2.24 The Tully Golden Gumboot gets rained on 150 days a year.

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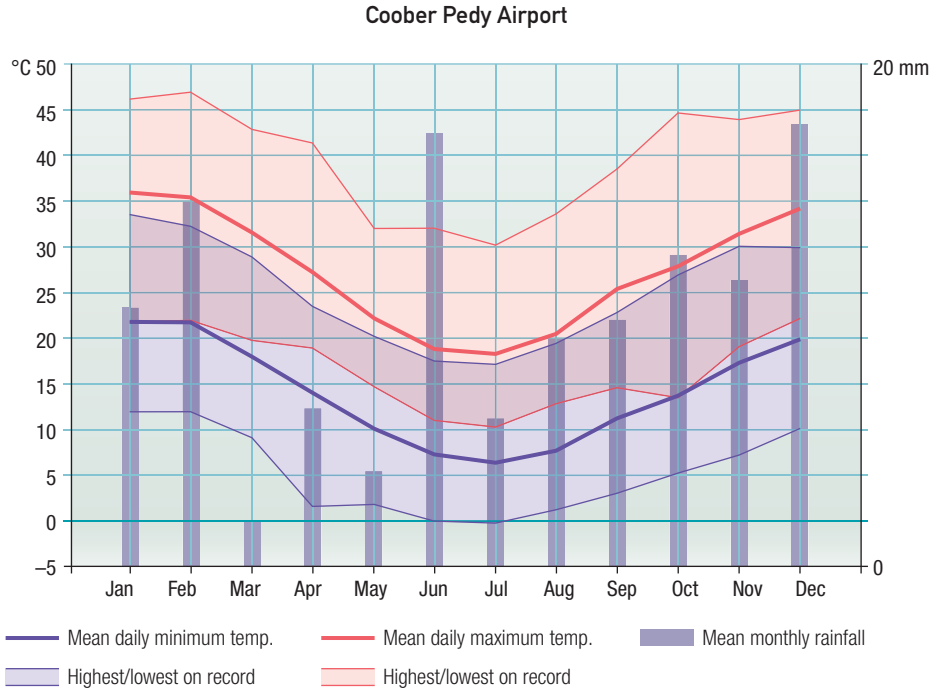
E: Inland Australia

Coober Pedy, located in inland South Australia, is one of the hottest and driest places in the country. Only 20 days a year experience rainfall on average for a total of 157 mm of rainfall per year (see Source 2.25). Coober Pedy is sometimes referred to as the 'opal capital of the world'. It is also famous for its underground houses, called 'dugouts'. Around half the town's residents live in these dugouts, which have a constant mid-20s temperature and provide relief from the relentless sun.

Just east of Coober Pedy is Lake Eyre. Typical of most of Australia in that it is flat and low-lying, the lake is mostly without water and is more of a salt pan. Water may enter Lake Eyre when monsoonal rains in Queensland flow along normally dry rivers into the lake. On the very rare occasions that the lake fills with water, it is the largest lake in Australia and the 18th largest in the world. During 2011 and 2012, Lake Eyre experienced times of being mostly full, after a few years of above-average rainfall and inflows. During these times, hundreds of thousands of birds migrated to the lake and the whole system was transformed. Even after this, the lake was quick to empty after a few drier months and warm winds, leading to typically high evaporation rates. In some ways, it is appropriate that Australia's largest lake contains dry, salty soils and is without water for most of its existence.

Geographical fact

At 15.2 m below sea level, Lake Eyre is the lowest point on the Australian mainland. The lake fills on average only 4 times every hundred years.



Source 2.25 Climate of Coober Pedy

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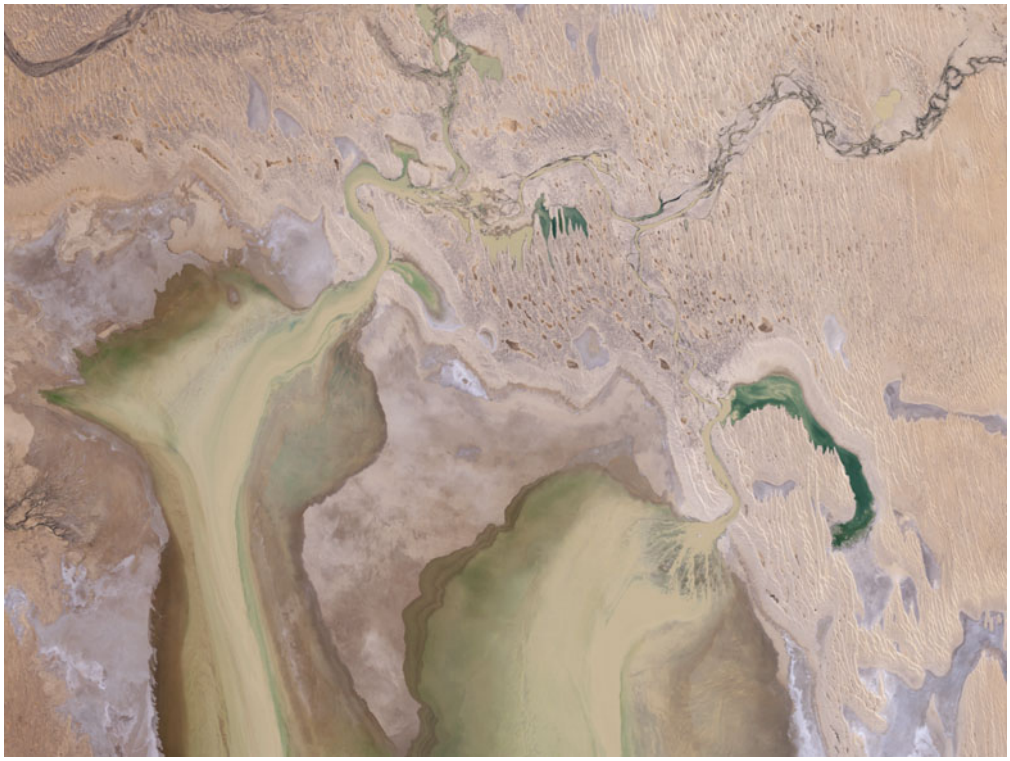

Source 2.26 Satellite image of water flowing into Lake Eyre, from the NASA Earth Observatory

F: Monsoon season

The 'Top End' of the Northern Territory and Western Australia has a relatively well-defined wet season that typically lasts from October through to April. During the winter months, rainfall is actually quite low in this region. The summer **monsoon** season occurs because of moist west to north-westerly winds moving in from the Indian Ocean and southern Asian waters, producing convective cloud and heavy rainfall over northern Australia.

monsoon seasonal winds that bring torrential rainfall

One of the most famous monsoonal rain systems occurs in India. From June through to September, Indian Ocean winds travel in a very different direction compared to those in October through to April, which we learned about earlier. These moisture-laden, south-westerly winds rush into India and are drawn towards the Himalayas. The massive mountain range acts like a high wall, forcing the winds to rapidly rise and create rainfall. Some areas of the region receive up to 10 000 mm of rain annually, and almost all of it within a few monsoonal months! Similarly, in South America the Andes mountain range blocks moist air from the Pacific Ocean to the east and, as a result, a significant amount of rain falls on the eastern side of the mountain range, which becomes the source of the tributary rivers that enter into the mighty Amazon.

Source 2.27 A flooded market in Varanasi, India

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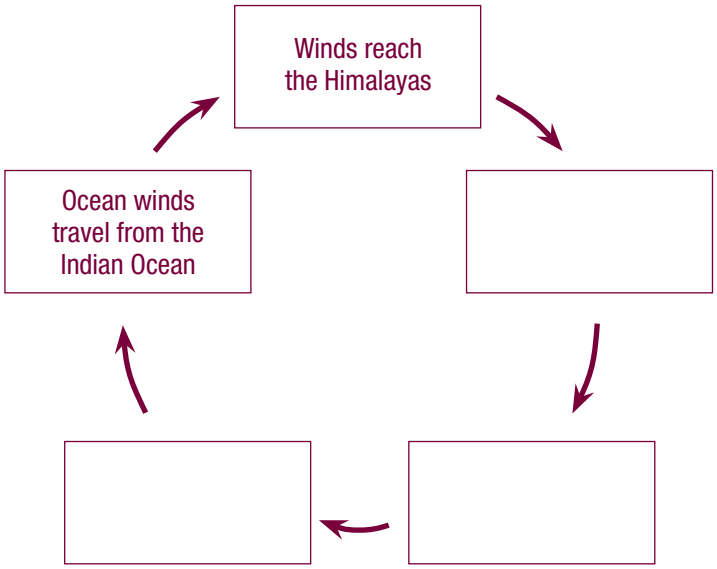
NOTE THIS DOWN

Copy the graphic organiser below and show how the monsoonal rains in India are created. (In order to help you visualise this, you may wish to use an atlas to source a map of the region.)



Here are some key points to remember: first, Australia is a vast continent with such incredible variation in weather and climate; second, while some regions (e.g. the northern coastline of Australia) may receive significant rainfall events, most of the country is dry with high evaporation rates.

ACTIVITY 2.4

1. What is the average discharge of water from the Murray–Darling river system, and how does this compare with other major world river systems?
2. Explain why Australian rivers generally have a very low flow rate on a global scale.
3. Refer to Source 2.18 and an atlas or on an online map of Australia. In pairs, discuss which type of rainfall you would expect the following locations to experience. Suggest potential reasons.
   - **a** Canberra
   - **b** Mt Gambier
   - **c** Cooktown
4. Evaluate why there is a higher rainfall on the east coast of Australia than on the west coast.

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RESEARCH 2.3

Investigate Lake Eyre and produce a digital presentation (e.g. PowerPoint, or a website using Weebly, Wix or Prezi), advertising it as a diverse and fascinating tourist destination. Present your advertisement as if you were the Lake Eyre representative at a tourism exhibition promoting Australia in another country. Include details on recent floods, cultural sites, the use of the land by Indigenous people, the changeable ecosystem (e.g. its role in the desert and as a periodic wetland environment) and any other interesting features of the region. You will find links to a number of useful websites at www.cambridge.edu.au/geography7weblinks.

Case study 2.1
The Pantanal wetlands

South America is a land of climatic extremes, with one of the world's driest deserts (the Atacama) lying not far from the largest river basin in the world in terms of size and water volume (the Amazon). Another vast region of rivers and catchments runs through central South America to the east coast. The Pantanal wetlands, spanning over 140 000 km^2 of Brazil, Bolivia and Paraguay, is considered to be the world's largest wetland area. South America's topography is like a huge bowl, with its flat interior ringed by mountains in the west, north and east. A significant amount of water drains into river basins – for example, the Pantanal wetland is drained by the Paraguay River, which then flows towards the Atlantic Ocean via another huge river basin, the La Plata Basin.

The Pantanal drains an enormous amount of water and sediments from surrounding highlands. However, this wild expanse is not always wet. Immense seasonal flooding (sinking the Pantanal under 5 m of water) is followed by periods of little to no rainfall when the wetland slowly turns into dry grasslands. While people sometimes struggle to survive in these extremes, the area contains

Source 2.28
The Pantanal wetlands

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biodiversity the number and variety of species of plant and animal life within a region

caiman a species of tropical American alligator

an amazing **biodiversity** of plant and animal species. During the dry season, **caimans** gather to breed, creating the largest concentration of reptiles on Earth. Rare giant river otters patrol the waterways in family packs, while predators such as jaguars flourish with such an abundance of available food. According to the season, you might observe large flocks of impressive bird species such as macaws or giant storks, giant guinea pigs (called capybara), armadillos or howler monkeys – just to name a few.

When the rainy season arrives, one of the world's largest waterfalls, the *Foz do Iguacu* (or Iguazu Falls), becomes a breath-taking spectacle. The falls, located on the border of Brazil and Argentina on the Iguazu River, were recognised by a global poll of 100 million votes as 1 of the New 7 Wonders of the World.

The Iguazu falls flow into a long and narrow **chasm** called 'The Devil's Throat', which is an enormous 82 m high, 150 m wide and 700 m long.

chasm a deep fissure or groove in the Earth's surface, formed by geological processes and water

1. Identify which countries the Pantanal wetland region spans.
2. Explain how you think the topography of South America contributes to large expanses of water in the continent's interior.
3. Analyse why there is such a rich biodiversity in the Pantanal.

Source 2.29 Rainbow over Iguazu Falls on the border of Argentina and Brazil

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FIELDWORK 2.1 WATER CONNECTING PLACES

Aim

To visit a local waterway or water source and explore how different parts of the environment are interconnected by water.

Method

Several organisations operate interesting excursions around the role of water in nature. For example, the Melbourne Water Discovery Centre (at the Western Treatment Plant in Werribee) provides students with an interactive journey of the water cycle through river systems. The centre also helps students discover how water connects places, from catchments to urban supply and treatment systems and eventually to bays and oceans.

Another example of a potential excursion is at the Toolangi Forest Education Centre (operated by the Gould League), which investigates the role of water in forest ecosystems.

Alternatively, you could investigate similar organisations in your school's local river system, travelling to different sites along the river – for example, 1 upstream near the river source, 1 halfway down the river and another close to the river mouth.

Preparations

You will need to take on your field trip:

- equipment for exploring the questions above (see if your science department has equipment for things like water quality tests and measuring velocity rates)
- a camera for photographs of each site
- a map of the river and surrounding area
- a pen and pencil for recording notes and annotated field sketches.

Data collection

Types of questions to explore include:

- How fast is the flow of the river at each site? (This can be measured simply using an item such as a stick or orange and timing its journey across a certain distance.)
- Is there evidence of processes such as erosion, transport or deposition? (Look at the shape of the river and along the river banks, as well as the colour of the river, to observe whether much sediment is being transported.)
- What are the width and depth of the river? (Check if it is safe enough to find out and only explore under direct teacher guidance.)
- What are the characteristics of the riverbank? (For example, observe vegetation types and cover, rock or soil characteristics, evidence of animal or human impact, and weed species.)
- Is there any evidence of recreation or other human activities being undertaken today or in the past? (This may be evident if studying larger rivers like the Yarra.)
- Is there any evidence of human impact (such as litter, erosion or pollution) or management (such as water storages, fences or signs)?

Fieldwork presentation layout

Present your findings, comparing all 3 sites, as a poster, report or digital display (e.g. PowerPoint). The focus question that should be addressed if studying a local river system is: 'How do the river system and its geographic characteristics change as you journey along its course?'

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Chapter summary

- Water cycles through Earth's 4 spheres (atmosphere, hydrosphere, lithosphere and biosphere) via processes such as evaporation, condensation, precipitation and run-off.
- Even though 71% of the Earth's surface is covered by ocean, only a fraction of the water is fresh and most of this is inaccessible to humans.
- Water is distributed unevenly across the Earth.
- Rainfall rates are variable and inconsistent, particularly in Australia.
- Run-off rates are crucial to the people and the environment and are influenced by rainfall, evaporation rates and the shape of the land. Run-off rates are particularly low in Australia.
- Water is found in all 3 physical states on Earth, each of which provides water with unique properties that make it such an essential resource for life on Earth.
- Water carves out the landscape through processes such as erosion, transportation and deposition.

End-of-chapter questions

Multiple choice

1 _____ % of freshwater on Earth is in the form of ice in glaciers or ice sheets.

A 35
B 55
C 75
D 95

2 Water moisture held in the soil is also referred to as:

A blue water
B green water
C grey water
D brown water

3 Water that has a salt content in between that of freshwater and seawater is called:

A saline
B blackish
C greenish
D brackish

4 The process by which chemicals in the air begin to loosen rock material is referred to as:

A weathering
B deposition
C abrasion
D hydraulic erosion

5 Which type of rainfall is associated with masses of cold air moving in from Antarctica?

A Orographic
B Conventional
C Cold front
D Convectional

ISBN 978-1-107-69012-7

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Short answer

1 Identify 2 reasons why the Murray–Darling river system has less than 0.2% of the flow of the Amazon River.

2 Deduce which process is associated with water movement from the hydrosphere to the atmosphere.

3 Recall how ocean temperatures influence the amount of rainfall that forms over different coastlines, for example the eastern coastline compared with the western coastline of Australia.

4 Which town was awarded a prize for being the wettest in Australia, and why does it receive so much rainfall?

5 Describe how the soil type influences the amount of run-off that enters a river system.

Extended response

Describe in detail the journey of water in a large river system as it travels from the river source (high up in the hills) to the river mouth (where it exits to the sea). You may need to research types of land forms associated with river systems and where they occur. For assistance, navigate through the website links at www.cambridge.edu.au/geography7weblinks.

You may choose to either draw a diagram of the river system (annotated with descriptions) or write your description as a story (with a water molecule as the main character). Include the following details in your description:

- how water enters the river system – via the water cycle
- processes of weathering, erosion, transportation and deposition
- land forms such as waterfalls, floodplains and estuaries or deltas.

Source 2.30 Cliffs along the Murray River in South Australia

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3 Value of water

Source 3.1 Surfers have long been a recognisable part of popular culture in Australia.

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Before you start

Main focus

Water is valued in different ways by individuals, groups and organisations in society because they all use water differently.

Why it's relevant to us

Water is all around us. It is a valued natural resource that plays a part in every culture on Earth.

Inquiry questions

- What are the different ways in which water is used?
- What values do people place on water?
- How does water contribute to identity?
- Why do people live near water?

Key terms

- Aesthetic value
- Agriculture
- Cultural value
- Dam
- Economic value
- Hydropower
- Identity
- Irrigation
- Proximity to water
- Recreational value
- River diversion
- River regulation
- Spiritual significance

Let's begin

People see and value water in different ways. Some use it for profit, some use it for sport and some link it to health. Others interact with it because water is a part of their culture and they appreciate it for what it is. Some people travel to see spectacular land forms shaped by water and amazing geographical features such as the Niagara Falls in Canada and the Victoria Falls in Tanzania. From the largest ocean to the smallest drop of rain, water affects people's daily lives; it is a precious resource that needs to be looked after now and for future generations.

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3.1 Uses of water

Transport

One of the earliest recorded uses of water was in ancient Egypt. When it was discovered that the Nile River was the fastest transport route through ancient Egypt, boats began to be built for various purposes. One of the more famous purposes was to carry massive stones hundreds of kilometres in order to construct the colossal pyramids. Travelling on the Nile River was an easy task when travelling northward, as the currents did most of the work.

When travelling against the current, cargo boats were rowed by teams of men with many sets of oars, although at times of low wind the men had to tow the boats along the river with long ropes from the banks. The Egyptian empire spread along the Nile, and transportation and trade allowed by the Nile were key factors in the formation of Egyptian society.

The 1400s through to the 1600s CE was a period known as the 'Age of Exploration', in which the discovery of new lands by ship led to important trade routes, for example between Asia and Europe. Many important sea ports were established, often in association with new settlements. One of the oldest ports in the world, dating back to 1900 BCE, is that of Alexandria, located on the western edge of the Nile delta. It still handles over three-quarters of Egypt's foreign trade. Settlements have been established throughout the world along coastlines and harbours, such as in Port Phillip Bay in Melbourne, which has been crucial to Melbourne's growth and development and is now Australia's busiest commercial port. The spectacular harbour of Rio de Janeiro is considered one of the natural wonders of the world, with the famous city of Rio squeezed in between the harbour and the beautiful granite mountains that surround it.

Several of the largest ports in the world today are located in China. Illustrating the rapid and immense scale of China's **industrialisation**, these ports connect the country with hundreds of other countries and ports around the world, and handle millions of cargo containers every year. They represent the enormous importance of water transport to the world economies and to **globalisation**.

industrialisation the modernisation of a country, involving large-scale infrastructure development, economic growth and a movement towards more efficient, mechanised methods of production

globalisation the process by which the world is becoming more interconnected, with an increase in social and economic integration between countries (e.g. an increase in international trade and communication)

Source 3.2 Today, the Nile River is still used extensively for transport, although some of the boats are bigger, more sophisticated and used for tourism (look at the number of cruise ships) and recreation among other purposes.

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Source 3.3 Qingdao port in China, located on the Yellow Sea, has connections with 450 ports in 130 countries and has strengthened significant trade relations with other nearby huge ports in Korea.

Geographical fact

Port Phillip Bay in Victoria handles over $75 billion in trade every year.

Agriculture

agriculture the farming of animals and plants (crops)

Mesopotamia the region around the Tigris and Euphrates rivers – modern-day Iraq

One of the most important uses of water throughout history has been in **agriculture**. Since the beginning of human settlements, water has been required to grow crops and food. The first successful efforts to control the flow of water were made in **Mesopotamia** and ancient Egypt, where a lack of rainfall caused the pharaohs to order the construction of underground canals to tap into groundwater aquifers. These canals, some several kilometres long, required a great amount of manpower to dig and operated using gravity to reach settlements throughout northern Africa and the Middle East, which relied on this groundwater for their existence.

Agriculture, like transport, has long been crucial to civilisations along the Nile River. With its source in a location of young volcanic rock in Ethiopia, the Nile erodes and transports 140 million tonnes of fertile volcanic silt each year. Much of this silt is deposited in flood plains along the river and as it reaches the Nile delta, creating ideal conditions for agriculture.

Rivers and groundwater sources are not the only places that have been farmed. Commercial fishing is one of the oldest and most important industries in the world. Today, more than 90 million tonnes of fish are captured each year

Geographical fact

Mesopotamia was part of the 'fertile crescent' along the Tigris and Euphrates rivers, a region that became known as the 'cradle of civilisation'. It was there that the earliest human civilisations developed, as the inhabitants were able to use the fertile soils and groundwater for agriculture.

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Source 3.4 Satellite image of the Nile delta, where the silt the Nile carries spreads out and extends into the Mediterranean Sea. Notice the stark comparison of the Nile River with the Sahara Desert through which it flows.

Source 3.5 The population density in Egypt clearly demonstrates people's continued dependency on the water of the Nile River, as well as the nutrients the river carries.

through commercial fishing, but at a cost, with hundreds of species extinct already and global fish stocks at critical lows. It is estimated that around one-fifth of all fish species are at risk of extinction, a figure which drastically highlights the need to apply more sustainable harvesting methods.

Whereas in the past fish were caught 1 at a time using a line and a rod, now fishing boats trawl the oceans using large nets. As well as catching vast amounts of fish, industrial fishing boats can also net large volumes of bycatch, consisting of species other than the targeted fish, which are then discarded. Bycatch can include turtles, sharks, whales, dolphins, porpoises and birds. The impact that these fishing practices have on the oceans is reflected in the plummeting fish stocks around the world.

Today, ocean agriculture also uses food and water resources on a significant scale. For example, seaweed farms have been established and are growing in places like China and Indonesia (Source 3.6). The harvested seaweed is used for food, medicine, fertilisers and industrial purposes.

Source 3.6 Sustainable seaweed farming in Bali, Indonesia. The seaweed grows on lines (resembling clothes lines or swimming ropes) and the local people trawl down the lanes on canoes.

Source 3.7 The Roman Baths, in the appropriately named city of Bath in England, are now a major tourist attraction.

Recreation

Water has always had properties that make it ideal for various recreational purposes. During the Roman occupation of Britain, hot springs (in which water is heated to between 64°C and 96°C by geothermal energy) were discovered, and the now famous bathing complex at Bath was constructed (see Source 3.7).

Today, swimming pools have been built just about everywhere possible, and they are a favourite pastime for much of the population. Water has also been used to keep sporting fields, as well as golf courses, green. The Yarrawonga golf course, located along the upper Murray River, uses water taken directly from the river. The Yarrawonga Weir was built in the 1930s to enable water to be channelled away from the river and onto irrigated farming regions in Victoria and New South Wales. The golf course, constructed a decade earlier, has since had to compete for its water requirements with other recreational users, such as boaters and water-skiers. Today, several golf courses have been grown in desert regions like Arizona and Dubai. These courses now hold significant international tournaments, and present striking examples of human utilisation of water and the contention involved in using water as a resource.

Spiritual wellbeing

Another value of water for people has been in its use for spiritual purposes. For example, the Ganges in India has been considered by many Indian people to possess supernatural powers, and it has thus played a dramatic role in their spiritual lives. Even before John the Baptist was anointing people in the Jordan River at the time of Jesus, water has been a symbol of cleansing and redemption for Christians.

Source 3.8 A crowded swimming pool in China, where some pools can hold tens of thousands of people – does this look like fun to you?

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Source 3.9 Golf courses in the desert use as much as a staggering 3.8 million litres of water a day. This can cause considerable conflict over water resources, although some courses are starting to use recycled water and more drought-tolerant grasses in efforts to reduce some of their water demand.

Source 3.10 Theme parks, such as Wet'n'Wild on the Gold Coast, have a very obvious reliance on water for recreation.

Aesthetics

aesthetic relating to the nature and appreciation of beauty

You only need to look at the beauty of rivers and waterfalls to recognise the **aesthetic** role of water in the landscape. Humans, likewise, have used water for aesthetic purposes, from elaborate fountains in Renaissance Europe to water features in domestic gardens throughout the world. Some of these features have also been used to demonstrate power and wealth. The Trevi Fountain in Rome, Italy, is one of the most famous fountains in the world. Water was sourced from an underground aqueduct that supplied water to ancient Rome. Oceanus (the god of all water) was placed in the centre of the fountain – a clear demonstration of the role of water in religion.

Water also has an important place in the history of military conflict. Civil defences have been built along coastlines and around harbours, and societies from ancient to modern times have fought important battles on the seas. Water features prominently in art, and has also been important in the industry of mining and in harnessing the power of water for hydroelectricity, which will be explored more thoroughly later in this chapter.

Source 3.11 The Trevi Fountain, constructed in seventeenth century Rome, is still one of the most beautiful and historic cultural landmarks in the region.

Health

Another notable use of water has been in health care and medicine. Hydrotherapy, the use of water for pain relief and treatment, is believed to have been used in ancient civilisations, such as that of the Greeks. Thermal springs have also been used for health and relaxation purposes by many cultures and peoples around the world, and even by monkeys in the mountainous Nagano region of central Japan (Source 3.12).

Source 3.12 Monkeys head to Japan's volcanic thermal springs to bathe, particularly when snow from Siberia sweeps over the Japanese mountains and temperatures plummet to below freezing.

ACTIVITY 3.1

1. Identify as many different uses of water you can find in this chapter. Suggest some that are not mentioned.
2. In 331 BCE, Alexander the Great cleared sand and silt deposits out of Alexandria's port to enable it to operate as the military base for his boat fleet. What was the likely cause of this sediment build-up?
3. Name a major water resource other than Port Phillip Bay that influenced the choice of Melbourne as the location for a new settlement. How do you think this resource was used?
4. Seven of the world's 11 largest cargo ports are located in China. With a partner, account for why this might be the case.

RESEARCH 3.1

Choose 1 of the following locations and investigate its use of water; for example, if it is for amusement, for transport, for aesthetic beauty or for other purposes:

- Suez Canal
- Tivoli Gardens
- Venice canals.

Write a report about the purpose this use has played in human history, including in the present day. Include photos in your report.

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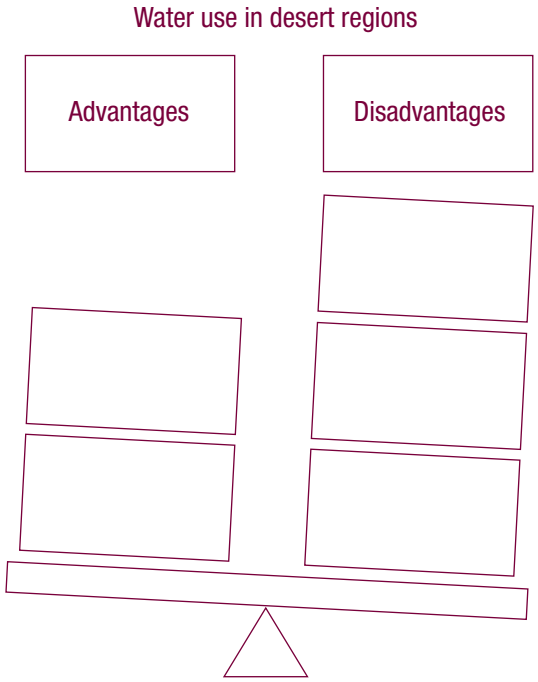
NOTE THIS DOWN

Copy and complete the graphic organiser and compare the advantages and disadvantages of water use in desert regions, for example on golf courses.
Decide whether you think water use for such purposes should be allowed to continue.



Case study 3.1
Ancient aqueducts

The Valens aqueduct, completed in 368 CE in Constantinople (modern-day Istanbul, Turkey), is an example of an above-ground aqueduct. Extending over 250 km in length, it had to be engineered with an exact slope gradient to ensure that water reached its intended destinations. It is a testament to the lengths civilisations will go to in order to use water resources. The aqueduct was the major water source for the city, and was completed during the reign of the Roman Emperor Valens, whose name it bears.

The Caesarea aqueduct was built by King Herod the Great and later expanded by the Romans. Caesarea was an important port city in Israel, built around 23 BCE. Herod's construction of a deep sea harbour highlights the variety of uses that water provided in ancient times. Markets, roads, baths

Source 3.13 The Valens aqueduct, now passing over a road in Istanbul, was restored several times during subsequent empires. The surviving section is only 921 m long.

ISBN 978-1-107-69012-7

and temples used water for trade, recreation and religion respectively. The city even hosted major sporting competitions, including gladiator games every 5 years in a theatre overlooking the Mediterranean Sea. The harbour provided for many of Herod's needs, but it was the aqueduct that supplied freshwater, transporting it through the arid region from springs 10 km away.

1 How long was the Valens aqueduct when it was built?
2 Explain why you think it was important that above-ground aqueducts were built with exact gradients for transporting water.
3 Suggest why the Caesarea (Source 3.14) aqueduct needed to be built.

Source 3.14 The Caesarea aqueduct supplied water to the city of Caesarea for 1200 years.

Economies and communities based on irrigation

Throughout history, people have been growing plants for food, materials, aesthetics and health remedies, among other purposes. Civilisations and societies have been built around agriculture and the trade it stimulates. In many countries of the world, including China, people still rely on farming to feed their own families; this is known as subsistence farming. All farms need water, and farms have always been either rain-fed – relying only on rainfall – or **irrigated**. Even in desert regions, people have tapped into water sources in order to irrigate farmland, as we shall investigate.

irrigate to water farmland using water that has been diverted (e.g. by human-made channels) from the river system

The Dead Sea

The Dead Sea, located in both Jordan and Israel in the Middle East, is the one of the saltiest locations on Earth. The salt concentration in the Dead Sea is a staggering 33.7%, compared with the salt concentration in the Mediterranean Sea, which is between 3.5% and 3.9%. This is largely due to its location at the deepest point (some 420 m below sea level) of the Great Rift Valley, where **tectonic plates** are drifting apart. Additionally, this is a very dry region where rainfall is low and evaporation rates high, leaving spectacular salt deposits (see Source 3.15). The Dead Sea's high salt content is what makes it possible for the unique floating experience enjoyed by swimmers (Source 3.16).

tectonic plates the giant irregular slabs that break up the Earth's crust; they move and cause volcanoes and earthquakes, as well as the formation of mountains, rift valleys and oceanic trenches

ISBN 978-1-107-69012-7

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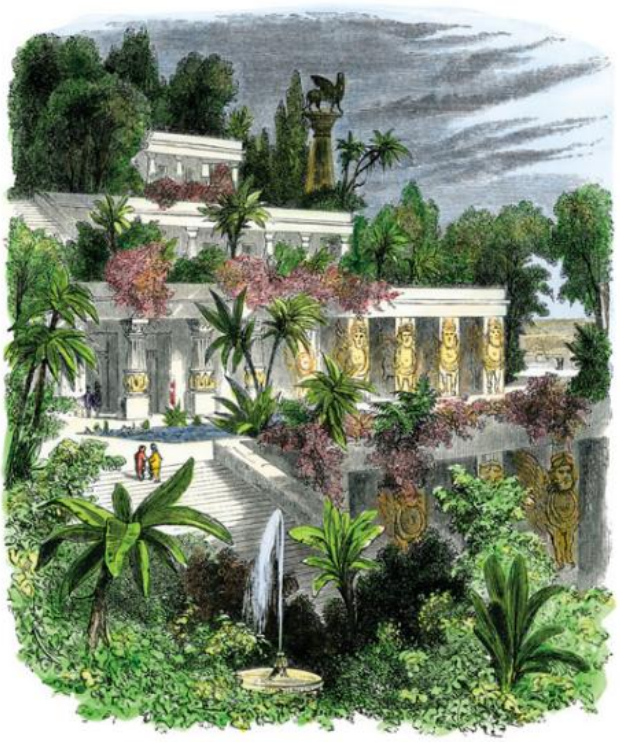
Source 3.15 Spectacular salt deposits on the edge of the Dead Sea

Source 3.16 Floating on the Dead Sea – a popular tourist activity

Geographical fact

The Great Rift Valley is a continuous trench, approximately 6000 km in length, which spans from Mozambique to northern Syria and is in the process of splitting the African (tectonic) plate in 2.



Salinity and high water tables in the Dead Sea make it virtually impossible for anything to grow there naturally. Despite these inhospitable conditions, agriculture is an important industry in this region, contributing to some 50% of the local economy. **Hydroponics** is an important method of agriculture near the Dead Sea. With plants often grown 'in the air', hydroponics has been used for centuries, the oldest known example being the famous Hanging Gardens in the ancient city of Babylon, supposedly built around 600 BCE, which are listed as 1 of the 7 Wonders of the Ancient World.

hydroponics a method of agriculture in which water and nutrients are applied to plants without the need for soil

Source 3.17 An artist's impression of the Hanging Gardens in Babylon. Due to very low rainfall, the Babylon gardens must have been irrigated by lifting water from the Euphrates River high into the air so it could flow down through terraces, watering the plants at each level.

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Source 3.18 Large hydroponics tents near the Dead Sea use collected rainwater to grow plants, including vegetables and flowers.

permaculture agricultural systems that are designed to be sustainable and self-sufficient

Another form of agriculture that has only recently been implemented in the region is **permaculture**. The Dead Sea Valley Permaculture project, initiated in the year 2000, is an ingenious system by which a combination of mulching, small trenches, micro-irrigation and careful planting has enabled a diversity of fruit trees to grow in an area where farming should be impossible.

Agricultural regions in different countries of the Middle East and northern Africa include some of the most amazing examples of technological advancements and human exploitation of the environment anywhere in the world. The Sahara Desert and the Arabian Peninsula are extremely **arid** regions where the little rain that falls either seeps into the desert sands or quickly evaporates. In such regions, where surface water is scarce, you can find some of the largest underground water systems on Earth.

arid having a severe lack of rainfall – below 250 mm per year

Libya

Libya, in northern Africa, is one of the driest countries on the planet, receiving less than 100 mm average annual rainfall. While the desert

Source 3.19 A date palm plantation near the Dead Sea

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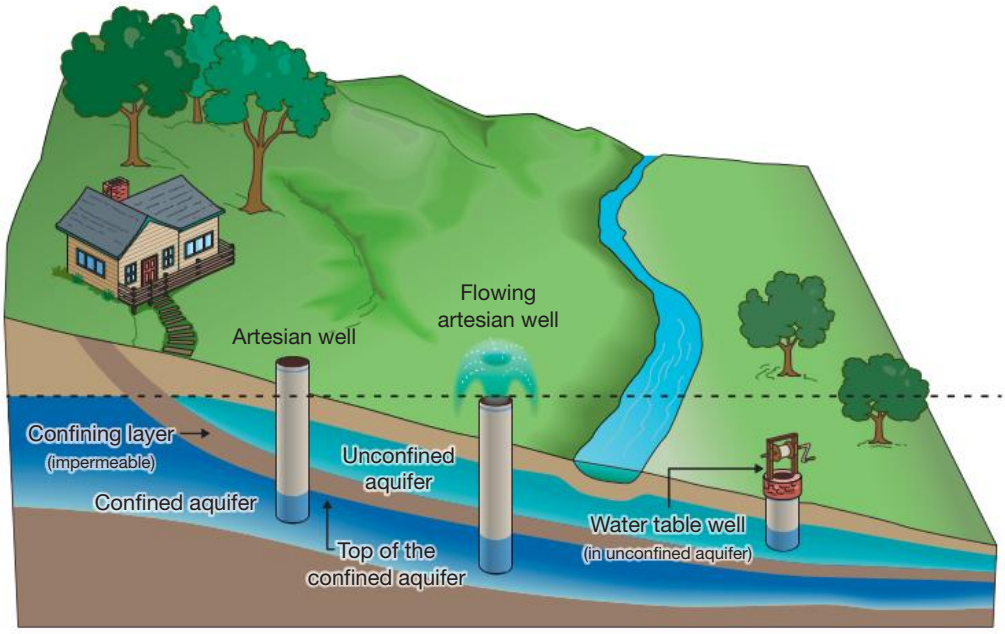
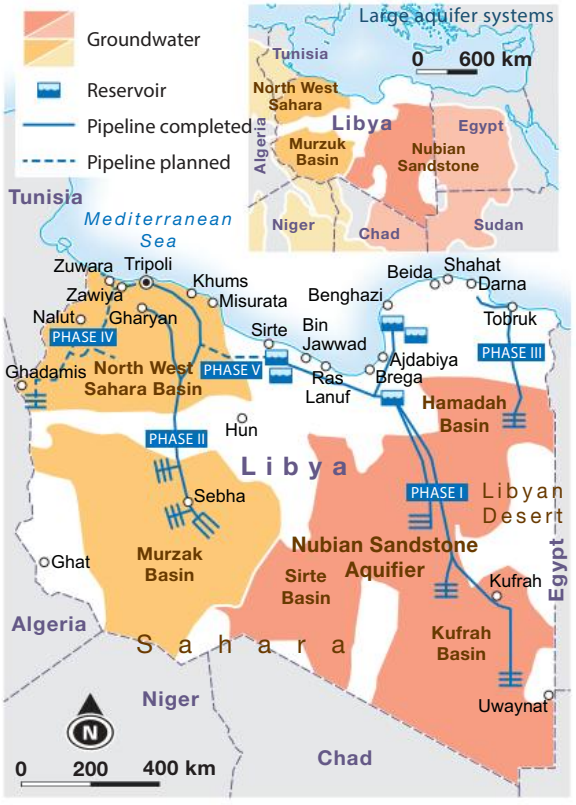


Source 3.20 An aquifer. Tapping into underground water systems, where water is confined between rock layers, is important in many regions worldwide.

in Libya was being searched for oil reserves in the mid-twentieth century, the Nubian Sandstone Aquifer System was discovered. This is the largest known fossil water aquifer in the world, located in 4 countries in the eastern end of the Sahara Desert. Fossil water is groundwater that has become trapped and sealed between rock layers for thousands or even millions of years. It is a **non-renewable** water resource, as it is not being replenished by rainfall.

non-renewable unable to be naturally replenished and sure to be used up at the human rate of use



Source 3.21 Libya has been working since 1985 to irrigate 387 000 acres of arid land and provide several major cities with water.

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The Nubian Aquifer spans an area of over 2 million km^2, and contains an estimated 150 000 km^3 of groundwater. Only in recent years has the potential of this water resource begun to be realised. In 1983, one of the largest engineering projects ever undertaken began in Libya. Appropriately named the 'Great Man-Made River Project', it will result in water being pumped through an incredible 4000 km of pipelines from 1100 wells and 5 major reservoirs when it is completed. This water will supply most of the domestic needs for Libya's 6.3 million people and, more significantly, will expand the nation's agriculture through irrigation.

Until Libya's pipeline project is completed, much of the population will continue to rely on **desalination plants** for their water needs. One of the problems with desalination plants is that they are very expensive, even compared with the Great Man-Made River Project. They also require a significant amount of energy to run, although at least the water being used is **renewable**.

desalination plants factories that convert seawater, through a complex scientific process, into fresh drinking water

renewable able to be naturally replenished and sure not to be completely used up at the human rate of use

Saudi Arabia

Like Libya, Saudi Arabia has been dependent in recent times on water from desalination plants. However, its major non-renewable groundwater reserves have also been tapped into and, amazingly, have been used to grow large quantities of various types of food. Around 95% of the farming area in this arid country is irrigated by groundwater at a rate that has become unsustainable. Although Saudi Arabia's groundwater reserves are being replenished by rainwater, the rate at which water is being taken for farming far outstrips this. Ironically, if Saudi Arabia is to continue its irrigated farming, it will need to do the opposite to what Libya has done, and increase its reliance on desalination plants. The cost to Saudi Arabia, already the largest producer of desalinated water in the world, of building new plants could reach a staggering $200 billion. This is a stark example of why water is such an incredibly valuable economic commodity and, unfortunately, why we so often overuse water in locations where there is a limited supply.

Terrace farming

We have transformed some deserts into agricultural oases, but many regions throughout the Earth receive enough rainfall to be intensively farmed without the need for irrigation. For centuries, civilisations have relied on rainfall to grow enough food to

Source 3.22 Desalination plants are dotted along the Saudi Arabian coastlines, utilising seawater as a resource.

ISBN 978-1-107-69012-7

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Source 3.23 Irrigated farmland surrounded by desert in the Middle East. This is an example of centre-pivot irrigation in Jordan, similar to systems in Saudi Arabia and Libya, where a long sprinkler system is attached to a central pivot and rotates around it, producing a spectacular circular irrigated field.

terrace farming a farming method in which a series of steps (terraces) are levelled on the side of a hill or mountain for agricultural production

be self-sufficient. **Terrace farming** shows some of the most visually striking examples of agriculture in the world. The most common crop type grown on terraces is rice, which thrives on the high rainfall rates in regions with high elevation and tropical climates. Rainfall runs off each terrace and on to the next, like a giant water feature, slowing the otherwise rapid surface run-off – a system that improves soil and water conservation.

Rice terraces are also common in regions of South-East Asia. For example, breathtaking terraces are found in mountainous regions near the Red River, which flows through southern China and Vietnam. In Sa Pa, northern Vietnam, rice terraces have been grown by ethnic tribes, while in Yuangyang County in southern China, terraces drop from summits some 2500 m high in the Ailao mountain range.

One of the problems of terrace farming in

Source 3.24 Some of the most spectacular examples of rain-fed rice terraces are in the Philippines. Terraces in the Ifugao region, within the Philippine Cordilleras (mountain ranges), are classified by UNESCO as a World Heritage Site as they represent a long history of sustainable farming practices in a location of dramatic beauty.

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Source 3.25 In South America, rice terraces were developed in the fifteenth century by the Inca people of Peru. They created the terraces on extremely steep slopes by building dry stone walls. The most famous of these are at the elevated ancient town of Machu Picchu. An icon of the famous Inca Empire, Machu Picchu was voted in 2007 as one of the New 7 Wonders of the World.

some regions is that maintaining the terraces can be costly and difficult. This is highlighted in the Ifugao region in the Philippines, where the terraces are beginning to collapse due to forest destruction and exploitation and damage by earthworms, since the nearby forests are located in the watershed area where water is collected. This is a reminder that environments are interconnected; when we affect 1 location, we are likely to affect another nearby.

The importance of irrigation

We have seen just a few examples of agriculture on a planet where farming has sustained life for thousands of years. We have heard about the importance of irrigation from fresh surface water and groundwater sources, in particular in regions where rainfall is low and/or variable. However, green water – rainfall that infiltrates and remains in the soil – has, throughout history, been every bit as important. Rain-fed agriculture produces around 60% of the world's staple food supplies. In some regions, such as sub-Saharan Africa, almost all food production depends on green water. With intensifying future challenges to agriculture, such as population growth, climate change and extended droughts, water (whether it be freshwater or green water) is critical to any vision of sustainability.

RESEARCH 3.2

Examine a groundwater system (natural or human-made) that is not discussed in this chapter (e.g. the ancient step wells of India, the underwater caves in Florida or an above-ground ancient aqueduct such as the Pont du Gard in the south of France). Produce a poster advertising your chosen system as a tourism destination. Include on your poster a location map, descriptions of the history and formation of the groundwater system, and photos.

ISBN 978-1-107-69012-7

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ACTIVITY 3.2

1 Suggest why plants find it difficult to grow naturally near the Dead Sea. Discuss 1 way in which this difficulty has been overcome in order to grow food in this region.

2 We have learned about the extraction of groundwater resources. An aquifer is the natural underground reservoir of water, whereas an aqueduct is a human-made channel for transporting and extracting (via wells) the groundwater. The earliest underground tunnel systems for extracting and transporting groundwater were in the dry mountain basins of Persia (now Iran). Twenty-two thousand *qanats* (types of underground aqueducts), spanning over 270 000 km in total length, were built by manual labour.

   a Describe how these *qanats* influenced population movement away from major rivers and their impact on the expansion of towns and civilisation into desert regions.

   b Identify the name of Libya's groundwater project.

   c What is fossil water, and why does extracting this water create issues of water sustainability?

3 Investigate a desalination plant in Australia. Explain how desalination plants are examples of both renewable and non-renewable resource use.

Water as an energy source

Imagine you are swimming in the surf at your favourite ocean beach, when a giant wave suddenly engulfs you. You tumble around like a sock in a washing machine, until you finally find your way to the surface and take a gasp of air.

As we turn on taps in our homes, we often think of water as a gentle, refreshing liquid. However, water can carry an enormous amount of energy, especially in the ocean or in the upper reaches of rivers, where gravity causes water to carve out spectacular landscapes. In an age where non-renewable energy sources such as oil are being overused and will eventually run out, one of the challenges to the human race is to harness the enormous potential energy of renewable resources like water.

Dams have been built in many countries and along hundreds of rivers in order to control the flow of these rivers. **River regulation** has allowed us to harvest river water for irrigation, flood prevention and the production of **hydropower**.

river regulation the building of dams and other structures so that people can regulate (control) the flow of water through the river system

hydropower the generation of energy by harnessing the power of water

The Snowy Mountains Scheme

The most important and controversial example of hydropower in Australia is the Snowy Mountains Hydro-Electric Scheme. The scheme took 25 years to complete and was finished in 1974.

Geographical fact

More than 100 000 people from over 30 countries came to work on the Snowy Mountains Scheme, which ran from 1949 to 1974. The scheme was part of a vision to not only generate electricity for homes and industries, but to also feed a growing nation.

ISBN 978-1-107-69012-7

Consisting of 16 major dams, 7 power stations and 225 km of tunnels, pipelines and aqueducts, it is one of the largest and most complex **hydroelectric** schemes in the world.

hydroelectric operated by, or production of, hydropower

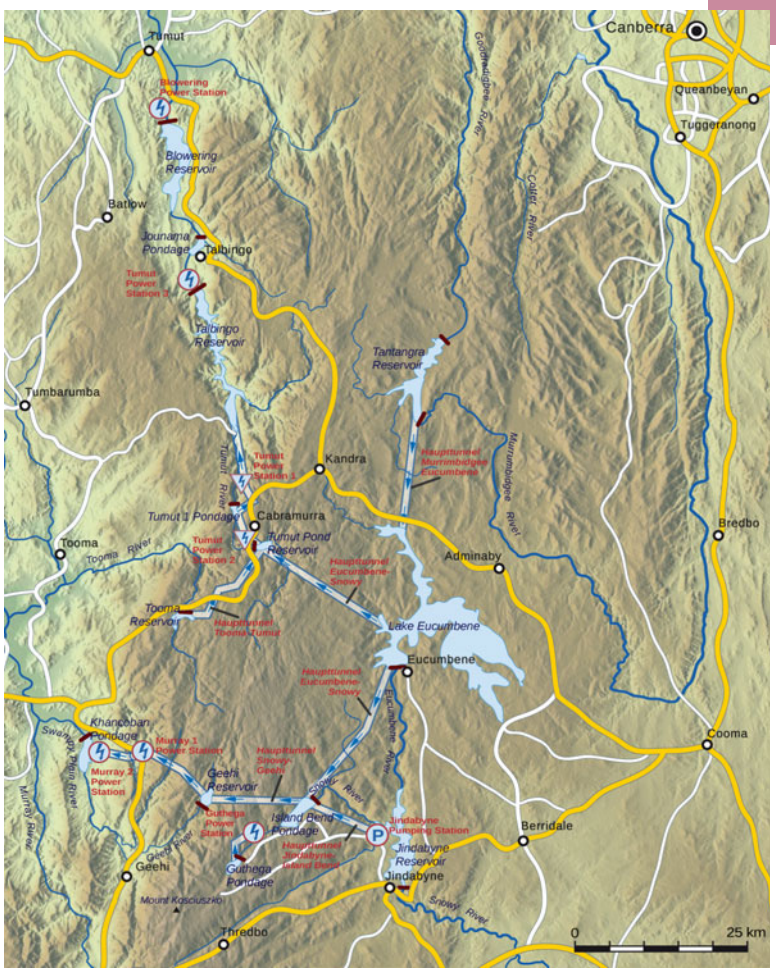
diversion the transporting of water away from a river, normally for the purpose of irrigating farmland

The Snowy River begins in the Snowy Mountains and flows south towards the sea. The scheme collects run-off that would normally flow into the Snowy River and creates a **diversion** via tunnels cut through the mountains, into dams and then inland into the Murray–Darling Basin. The dams – including one of the largest dams on mainland Australia, the human-made Lake Eucumbene, with a capacity 9 times the volume of Sydney Harbour – enable water to be converted by power generators into electricity. The power stations produce up to 10% of all electricity needs for NSW, although this figure varies depending on the volume of water flow from rainfall and snowmelt run-off. Water that is released from the dams is diverted into the Murrumbidgee and Murray rivers, contributing to the water supply of vital irrigated farming industries along these rivers, as well as sometimes bringing a little drought relief to inland Australia.

While the Snowy Mountains Scheme is a demonstration of our ability to harness natural resources, it unfortunately also highlights the potential environmental cost of using too much of these precious resources. Diverting water for the scheme has significantly changed the nature and flow rates of the Snowy River and others in the region. In some places, the Snowy River was reduced to a trickle – a mere 1% of the natural flow rate that had existed before the scheme began. When the dams were built, some **ecosystems** were also degraded. Action is finally being taken by the Victorian and New South Wales governments to restore river flows to the minimum level considered healthy (28%), while also investing in water saving projects to ensure irrigation farmers still receive adequate water supplies.

ecosystem a community of living things, including animals, plants and microorganisms

Source 3.26 The Gathega Dam, which supplies water to the Gathega power station as part of the Snowy Mountains Scheme



ISBN 978-1-107-69012-7

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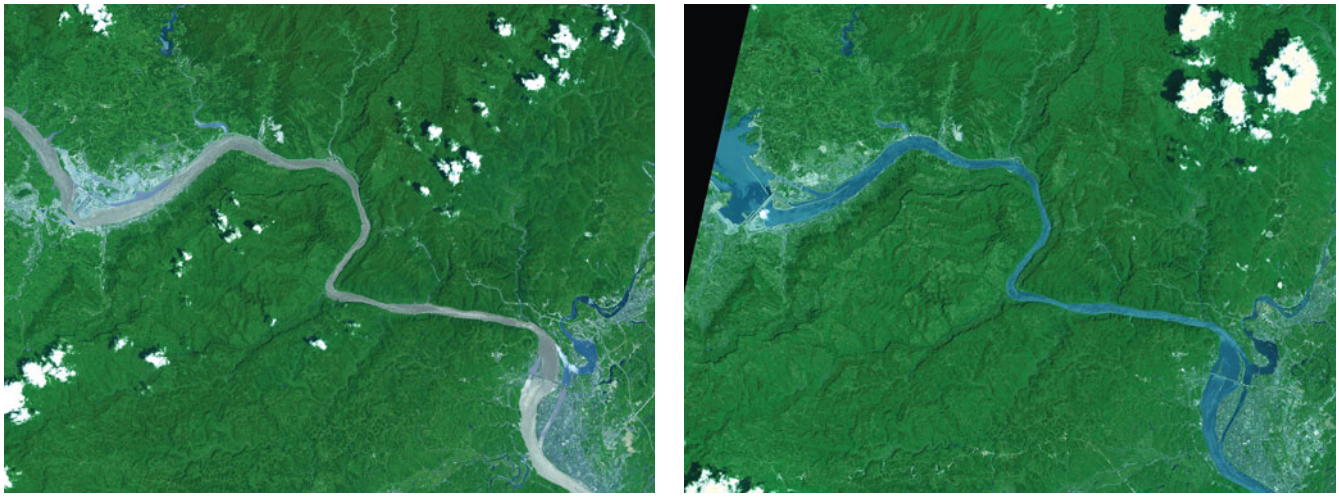
Source 3.27 Steep gorges give the Yangtze River both its aesthetic beauty and its potential power.

The Three Gorges Dam

Another controversial and also enormous hydropower scheme is the Three Gorges Dam on the Yangtze River in Hubei Province, China. The Three Gorges region, where spectacular steep cliffs tower over the landscape, has been given the highest rating (AAAAA) for a scenic area by the China National Tourism Administration. Besides its natural beauty, historical settlements and archaeological sites make the gorges a culturally important region in China. The dam, spanning the mighty Yangtze River on the Xiling Gorge, is the world's largest capacity power station. The project is part of China's plan for 15% of its total energy production to come from renewable sources. It generates 22 500 megawatts of power – around the same energy produced by 18 coal power plants, and enough to supply Beijing with power for a whole year.

An added benefit of the dam is the improved navigation of boats along the course of the Yangtze. Due to the steep walls of the gorges, travel along the river was often treacherous. The Yangtze River accounts for 80% of China's inland shipping, and is crucial to China's expanding



Source 3.28 Satellite images of the Three Gorges Dam construction. (The image on the left is from 2000, and the image on the right from 2006.) Notice the difference in water volume behind the dam wall after near completion in 2006, and notice near the top the narrower waterway, which is the five-tier lock.

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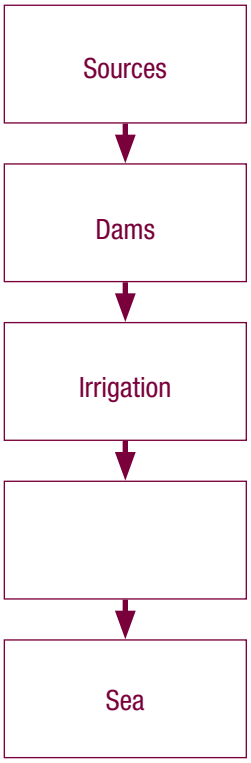
Source 3.29 The power of water (harnessed by huge generators) as it is released through the wall of the Three Gorges Dam. This photograph was taken at a time of massive flooding in 2010, where the dam was nearly full and was unable to prevent hundreds of deaths and the displacement of millions of people from their homes.

industrialisation. Behind the dam, water levels in the Yangtze are elevated as much as 110 m above the downstream river, widening the river channel and accommodating larger cargo ships and even tourism cruise ships. Some evidence indicates that this shift in water volume will actually slow the rotation of the planet! The installation of a 5-tier ship lock and elevator, which literally raises the ship to the upstream river level, enabled a massive increase in cargo load transported from Shanghai to the emerging megacity Chongqing, a city undergoing dramatically rapid development and urbanisation.

Along with the enormous benefits of the Three Gorges Dam come significant costs. The most publicised issue created by the dam was the relocation of people from upstream riverbanks. While flooding of the dam downstream, where millions of people reside, was being controlled, the reservoir itself flooded and about 630 km^2 of land containing villages, farms and important historic sites were inundated. As of June 2008, China relocated 1.24 million residents, with some claims of no compensation. Other impacts include degradation of ecosystems such as forests, a reduction of silt and nutrient levels downstream and an increased risk of landslides. The Three Gorges Dam demonstrates that human regulation of river systems will always come with both benefits and costs.

NOTE THIS DOWN

Select a major river in the Murray–Darling Basin (e.g. the Murray River or the Goulburn River) and use Google Earth to view its course. Copy and complete the graphic organiser below and show the changes you notice along the river's course from source to sea, including any evidence of regulation (e.g. dams), changes in width, human uses, and so on.



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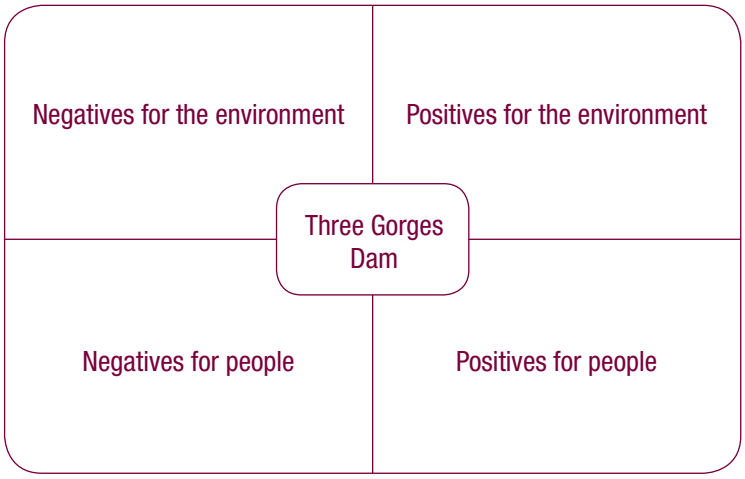
ACTIVITY 3.3

1. Explain, in your own words, what hydropower is.
2. What were the 2 main purposes of the Snowy Mountains Scheme? Why does the amount of energy produced by this scheme vary?
3. Describe 1 environmental issue created by the Snowy Mountains Scheme.
4. What is the name of the major hydropower dam on the Yangtze River? How does this dam contribute to China's aim of increasing its renewable energy production?
5. In pairs, discuss why China's renewables aim is particularly important in China today.

NOTE THIS DOWN

Copy the graphic organiser below and investigate the positive and negative impacts (on both people and the environment) of the Three Gorges Dam. For the negative impacts, explore the potential solutions.



Case study 3.2
Murray–Darling Basin

The Murray–Darling Basin contains the catchment areas of the Murray and Darling rivers and their many tributaries. It drains large sections of 4 states of Australia, including much of New South Wales, as well as the ACT. The Great Dividing Range runs along the eastern edge of the Murray–Darling Basin, providing the source of water for the major rivers. Much of Australia's rainfall originates in the east and falls over the Great Dividing Range. However, most of this rain runs down the eastern side of the ranges and flows back towards the coast. The rain that does fall on the western side of the ranges runs into the Murray–Darling Basin. Of this rainfall, only 4% ends up as run-off, as 94% evaporates or transpires through plants and a further 2% drains into the ground. Since most of the basin is relatively flat and low-lying, it takes considerable time for water to travel through the river system. This,

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Source 3.30 Major rivers and towns in the Murray–Darling Basin. The major tributaries that run into the Darling River begin in southern Queensland and northern New South Wales, while the source of the Murray is in the highlands on the NSW–Vic border. Both rivers flow towards South Australia and exit into the Southern Ocean at the Murray mouth, south-east of Adelaide.

combined with a relatively hot and dry climate, contributes to such high evaporation rates and water loss.

The basin receives just 6% of the country's annual run-off, and yet it is Australia's most significant farming region. The Murray–Darling Basin, sometimes referred to as 'Australia's food bowl', produces some 39% of the nation's income from agricultural production. Well over 3 million people (living within or close to the basin) rely directly on this region for water use, while millions more (e.g. in major cities like Sydney and Melbourne) consume various foods produced in the basin. When you go to your local supermarket, it is so easy to pick up a steak for dinner, or a nice juicy orange, and not think about where it has come from. It is more than likely that it would have been grown somewhere in the Murray–Darling Basin, and it would have required a significant amount of water to grow. For example, CSIRO land and water scientists have measured that it takes 50 000 to 100 000 litres of water to produce just 1 kg of beef!

Source 3.31 Diverting water from rivers in the Murray–Darling Basin for irrigated agriculture such as dairy farming is crucial for Australia's food supply and economy. However, water use will need to become more efficient as the need for water resources, and therefore competition, grows.

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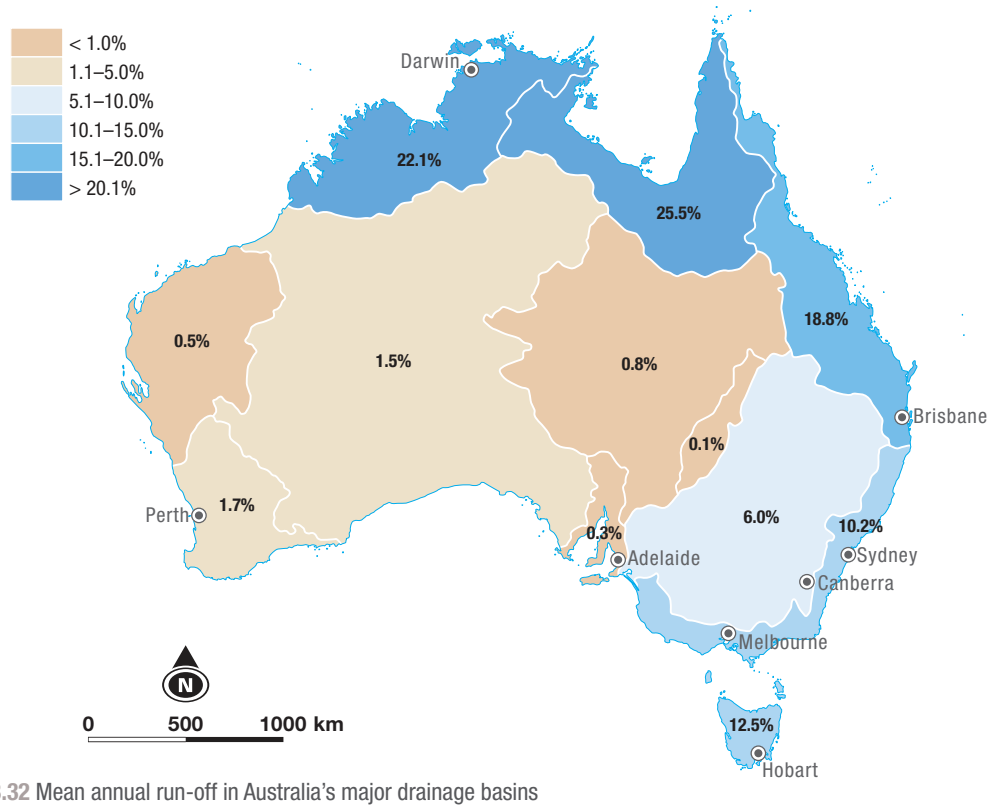

Source 3.32 Mean annual run-off in Australia's major drainage basins

Considering Source 3.32, you can see that the Murray–Darling Basin is a region where every drop of water is highly valued and used. The map shows that regions in northern Australia receive significantly more run-off, and yet they are not farmed to anywhere near the extent or intensity that the Murray–Darling Basin is. Conflicts in the Murray–Darling region have arisen over recent decades, due largely to competition for water resources. Farming groups, **conservationists**, governments, local residents and other groups all value water differently, and the amount of water available does not always meet everyone's needs.

conservationists people who work to protect the natural environment and its living organisms

The Murray–Darling Basin is a busy area, particularly agriculturally, with various types of farming distributed throughout different regions of the basin. The Murray–Darling Basin accounts for more than 70% of the irrigated agriculture in Australia. Its economic value to the nation is enormous, as irrigated crops are worth billions of dollars each year to the Australian economy. The main types of irrigated farming include rice, dairy, cotton, grapevines, fruit and vegetables. Rice in Australia, for example, is grown almost entirely in the Murray–Darling Basin, in the irrigation regions along the Murray and Murrumbidgee rivers. Unlike the spectacular rice terraces in regions of Asia that we saw earlier, rice farms in places like Deniliquin and Leeton in New South Wales (see Sources 3.30 and 3.33) require more water than natural rainfall is able to provide, and so water is diverted from the rivers by gravity onto these farms. Cotton is grown mostly along the upper Darling and its tributaries in southern Queensland and northern New South Wales. Cotton farms in these regions do not divert water directly from the rivers; rather, they are often situated on the river flood plains, and harvest rainwater before it enters the groundwater and potentially cycles into the river system.

The way in which we use water in Australia has long been influenced by European settlers, who were accustomed to high rainfall rates and a never-ending water supply. Droughts in recent decades, particularly through the very dry years of the mid-2000s, made it clear that this mindset in a predominantly dry country could not last. Later on

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Source 3.33 Murray–Darling Basin showing major irrigation areas and highlighting the intensity of irrigated farming and therefore the competition over water resources along major rivers such as the Murray, Murrumbidgee and Lachlan rivers

wetland environment an area of land that is saturated with water, either permanently or periodically. It is an important ecosystem with a unique set of animals and plants.

in this book we will learn about how water management has become crucial to ensuring that the river and important **wetland environments**, as well as farms throughout the Murray–Darling Basin, maintain a sustainable water supply both today and in the future.

Just as there are various types of farming in the Murray–Darling Basin, there are different ways in which the farms are watered. Some farming regions, particularly along the Darling River, rely

Source 3.34 A cracked river bed close to the Murray River in South Australia, where water had completely dried up in 2007. Throughout the period of drought (2003–09), water rarely reached the lower parts of the river and it became very clear that water use at these low rainfall rates was becoming unsustainable.

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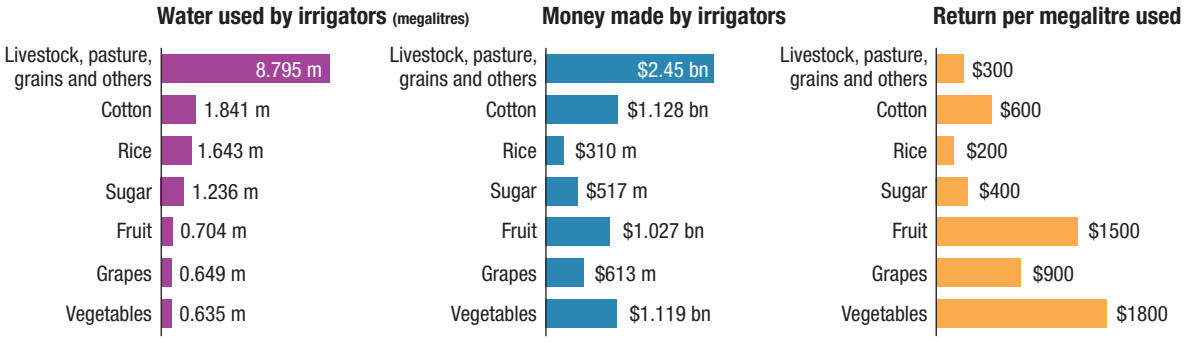
only on rainfall. Other regions, such as those along the Murrumbidgee River, use irrigation water diverted from the river. How crops are irrigated depends on the water requirements of that crop. For example, rice farming requires the whole field to be flooded with water, whereas fruit and vegetables are often irrigated by sprinklers or drip systems, in which holes in tiny pipes drip water directly onto the plant roots. A significant amount of water is lost into the soil by flood irrigation or by evaporation from sprinklers. More efficient systems (such as drip irrigation) as well as improved technologies (such as computer systems that detect plant water stress) make certain farming methods much more water-efficient than others. In Australia, there is considerable debate about whether we should begin to move towards using only water-efficient and sustainable farming methods.

Australia's agricultures



1 megalitre is similar to 1 Olympic swimming pool

Source: *The Weekend Australian* 19–20 May, 2001

Source 3.35 Not only is water use per crop important, but so is the economic return (amount of money made) per amount of water used.

Source 3.36 Different types of irrigation, each very different in terms of water use and water loss: flood, sprinkler and drip

We can conclude from water use practices in the Murray–Darling Basin that, even while making significant efforts to apply more water-efficient methods and technologies, we need to start considering alternative sources for our water requirements. Comparing the maps of Australia's rainfall and population distribution (Source 3.37), we can see that the population along the east coast is supported by reasonable levels of rainfall, combined with run-off from the eastern side of the Great Dividing Range. However, some regions of high population density, such as around Adelaide, have lower rates of rainfall. Just as importantly, regions of higher rainfall, such as those along nearly the entire northern coastline, have much lower population densities. The question arises – is this a largely untapped potential water resource in Australia?

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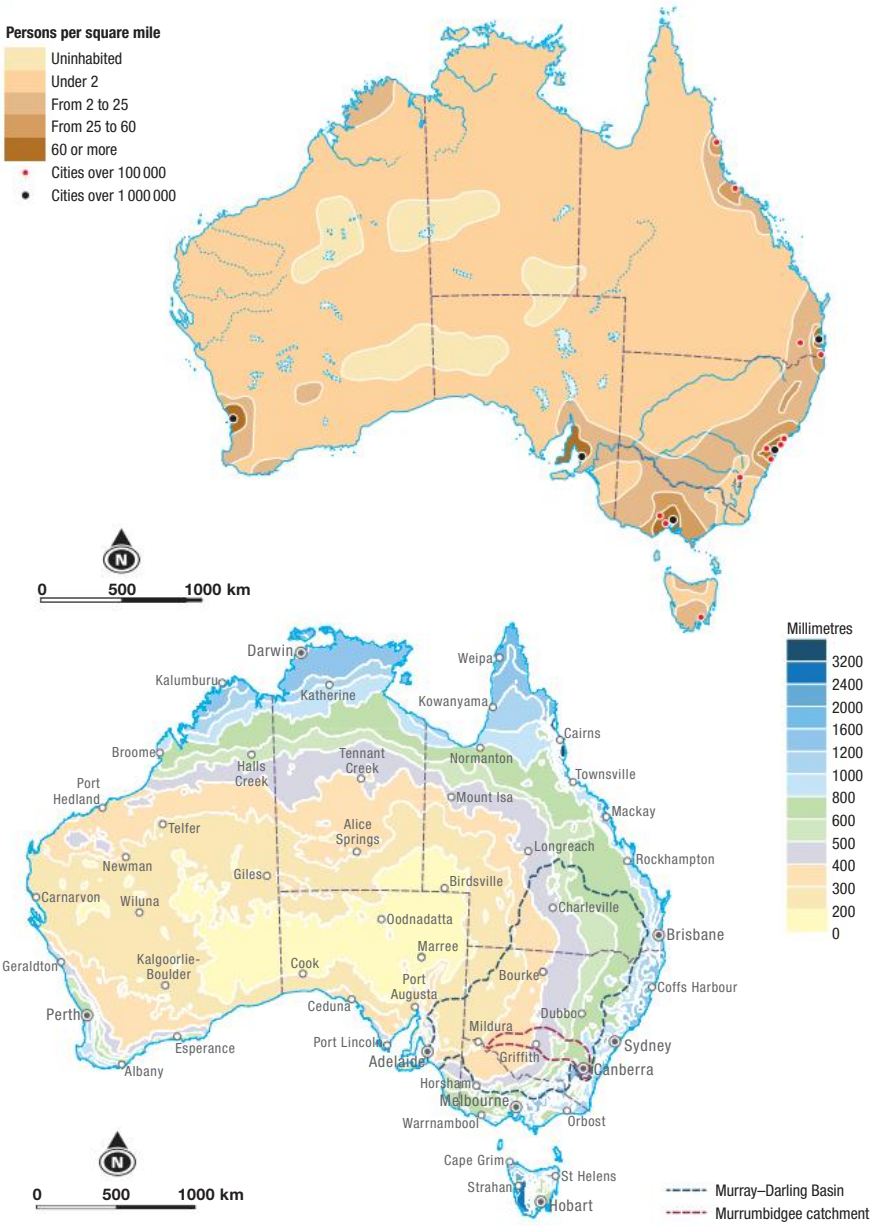

Source 3.37 Population and average annual rainfall distribution in Australia. The rainfall map includes the Murray–Darling Basin catchment area and the Murrumbidgee catchment within it, where rice farms near Leeton are located.

With significant investment and effort, northern regions of Australia could become an important additional food bowl in Australia, especially with global food shortages. However, it is important that we manage water resources with a degree of caution. The Great Artesian Basin is Australia's biggest groundwater basin, and the largest groundwater system of its type in the world. As we can see from the map in Source 3.38, a large area in the south-eastern region of the Artesian Basin is located underneath the Murray–Darling Basin. Some of the underground flows in the Artesian Basin recharge rivers in the Murray–Darling Basin, connecting these major systems.

The Great Artesian Basin has been considered a water source in Australia for many years, with thousands of groundwater **bores** extracting water from the. In arid western regions of New South Wales that are also within the Murray–Darling Basin, these bores are the only source of water for some towns and farms. However, significant issues have arisen with this water use. Most notably, the amount of

bores holes drilled into the ground to extract groundwater

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water extracted from the Artesian Basin has in many areas far outstripped the rainfall entering and recharging the groundwater, especially since some areas are too salty to extract from. Some animal species have become extinct as a result. Another more recent issue has been the possible chemical pollution resulting from coal seam gas extraction, which would potentially not only cause environmental damage but also reduce the sustainability of water use in these regions.

In conclusion, water use in Australia and indeed throughout the world needs to become much more sustainable if we are to use it in the future for as many purposes as we do today.

1 Through which states and territories of Australia do rivers in the Murray–Darling Basin flow?

2 Identify which mountain range is the source of most rivers in the Murray–Darling Basin.

3 Suggest why there are low run-off rates in the Murray–Darling Basin.

4 Discuss why the Murray–Darling Basin is important not only to people who live in the basin, but also to those living outside the basin.

5 Explain the distribution (locations) of major irrigation areas in the Murray–Darling Basin.

6 Compare water use between irrigated cotton and vegetable farming. Refer to Source 3.35 for help.

7 The money made by irrigated cotton and vegetable farming is relatively similar. Explain how this occurs, in terms of money return per amount of water used. How do you think each crop type may differ in terms of irrigation methods used?

Source 3.38 The Great Artesian Basin. The arrows show the direction of water flow through the groundwater system, with water at some points entering important rivers and lakes, some of these located in the Murray–Darling Basin. The dark green regions represent areas where water enters and recharges the groundwater basin.

8 Identify the name of the major groundwater system in Australia. In pairs, discuss why this system is in trouble and what, if anything, should be done about it.

RESEARCH 3.3

Create an information sheet that addresses the following points:

- the meaning of the terms 'river diversion' and 'river regulation'
- an investigation of how the Murray River has been regulated since the early 1900s using dams and weirs, including the Hume or Dartmouth dams and the Yarrawonga Weir
- the positive and negative impacts on people and the environment caused by this regulation.

You will find links to help you with this task at www.cambridge.edu.au/geography7weblinks.

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Geographical fact

Several organisations run interesting excursions on the theme of water use. For example, the Centre for Education and Research in Environmental Strategies (CERES) Environment Park in East Brunswick, Melbourne, focuses on environmental issues affecting urban areas, such as water use. Its programs give you an awareness of how your water use at home can affect the sustainability of urban water supplies, as well as systems and new technologies that are enabling water use at various scales to become more efficient. Located along the Merri Creek, the site also offers a study in river health and how human use can influence a river system. Other organisations include water providers such as Central Highlands Water, which runs tours to rivers, pipelines and storage reservoirs in regional Victoria, focusing on the human use and impact of river systems.

FIELDWORK 3.1 EXPLORING THE USE OF WATER

Aim

To investigate how humans have used water, be it on a small scale such as in the home or on a larger scale such as the use of river water for farming or recreation.

Method

Your home or a chosen river will be analysed.

Preparations

You will need:

- a camera/mobile phone camera
- a pen or pencil
- paper (in a clipboard).

Data collection

- A ferry cruise along the river: for example, various tours operate along Sydney Harbour, from Circular Quay west up the Parramatta River, north to famous Manly or east to Watsons Bay. Likewise, tours run from Southbank in Melbourne's CBD and travel along the river to fascinating places like the Docklands. Investigate the use of the river today and in the past. Interesting aspects may include the role of the original docks and river transport in shaping the city's history and the cargo ships that continue trade today. Take photographs of the journey and record your observations.
- A study of the water use in your home: investigate how your water use compares with your nearest city's averages and ways in which you could reduce your water use at home. For example, measure the amount of water used in the home over a week by recording the water meter figures each day, as well as recording how many times the dishwasher and washing machine are used or how long your showers are each day. See the link at www.cambridge.edu.au/geography7weblinks to compare your use with average water consumption and to obtain ideas for saving water. Try recording water use for a second week while implementing some of these or your own water-saving ideas.

Fieldwork presentation layout

Present your findings as a report, including a table comparing each week's water use.

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3.2 Water as a marker of identity

Identity refers to the way you see yourself and the way others perceive you. A few communities such as river people, surfers and islanders have unique identities as a result of their interactions with water. Some communities are created around water and identities are created around different interactions with water, leading to the development and maintenance of customs, traditions or a particular way of life. In the same way, a lack of water also provides an identity for people no matter how remote they are or how dry the land is.

River people

aquatic relating to water e.g. in reference to plants, animals or activities

Millions of people around the world live alongside rivers for a number of reasons, such as freshwater availability, transport, **aquatic** resources and aquatic activities. Along the Murray River, which divides New South Wales and Victoria, the largest group of Indigenous people was the Bangerang who lived in the area now known as Echuca. Living near the water created a different sense of identity for the Bangerang when compared to other Indigenous groups, such as those of the desert or **saltwater** country, because different resources were available to them. They used nets made out of rushes growing beside creeks to catch birds, fish and other animals. Their diet was different from that of other people too, because of the differences in flora and fauna in the region. Flooding of the river played a significant role in the seasonal movement of the Bangerang, who responded to the seasonal variations in river flow. So water, in this example, has **cultural value** and is a marker of lifestyle, identity and activity.

saltwater describing a group of Indigenous people from the north of Australia in an area marked by coastal and marine environments including mangroves and coral reefs

cultural value the emphasis placed on something for its importance and place in society, such as the inclusion of water in rituals, heritage and the Dreaming

Surfers

Surfers have a unique identity due to the nature of their sport. Reliant upon water conditions and large swells, they have a certain 'look' and way of life. The surf is a marker of their identity. With wetsuits, fibreglass boards, tanned skin, zinc and specific use of language, surf culture is present all around the coastlines of Australia. Sydney's northern beaches from Manly to Palm Beach offer over 20 km of sand and surf to its visitors. Famous breaks such as Bells Beach in Victoria and Margaret River in Western Australia attract tourists from all over the world.

Source 3.39 Country of the Bangerang people in the Murray River region

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Islanders

Water is a marker of identity for some island nations in the Pacific Ocean, such as Palau, Fiji and Samoa. The iconic bungalows over crystal-clear water, coral reefs and unique cultures have resulted in a booming tourist industry. Aquatic activities such as fishing, snorkelling and scuba diving are common. The different cultures of islanders and their different ways of life have largely been dependent on water. Ceremonies, foods and traditions stem from water resources and their cultural significance. For example, community fishing is controlled by a fishing chief who is bound by strict traditional rules and the whole community is involved in catching schools of fish such as mullet.

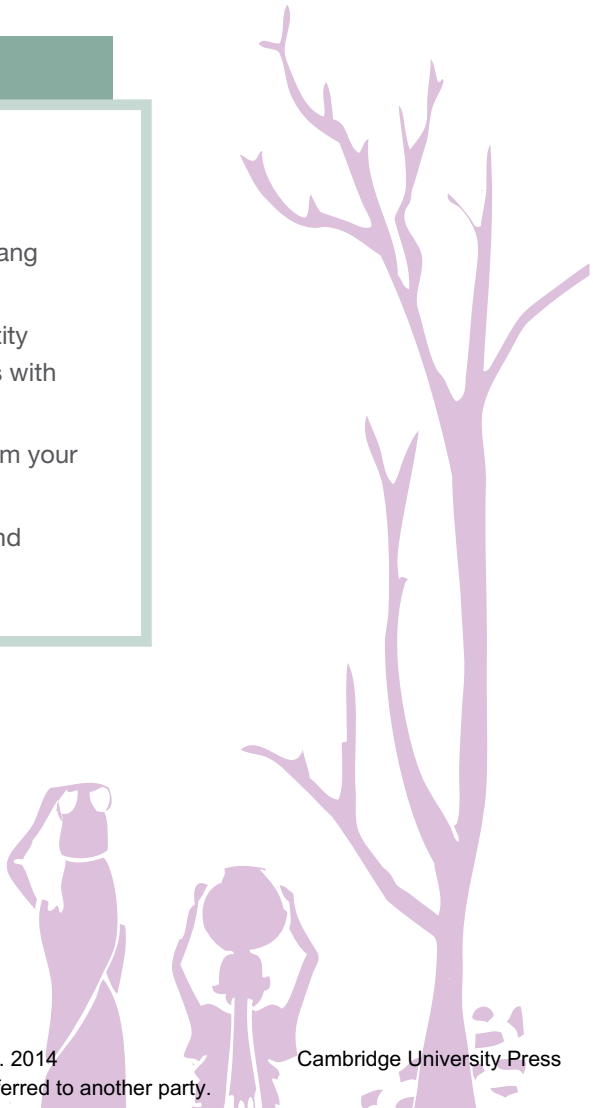
Boaties

'Boaties' is a colloquial term for anyone involved in activities associated with watercraft such as yachts or motor boats. Those who sail yachts are sometimes known as 'yachties'. Boaties have formed a **subculture** in society, as they have certain common interests. Water forms a significant part of their identity, since much of their time is spent in and around marinas maintaining yachts, participating in races and enjoying leisure time on the water. Identity markers of boaties' may include broad-brimmed hats, zinc, boat shoes, collared T-shirts and waterproof, wind-resistant clothing. Some boaties belong to organisations that host fundraising nights, family barbecues and other social events. Sandringham Yacht Club in Melbourne and the Cruising Yacht Club of Australia in Sydney are just 2 examples.

subculture a group of people who share characteristics that are different from those of the rest of society

ACTIVITY 3.4

1. Define the term 'identity'.
2. Explain why people live on and near rivers.
3. Analyse how the Murray River affected the Bangerang people's way of life.
4. Reflect on how a lack of water may affect the identity and way of life of some people. Discuss your ideas with a partner.
5. Conduct an internet image search for 'surfers'. From your results, describe the typical identity of a surfer.
6. Compare and contrast the identities of islanders and boaties.



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RESEARCH 3.4

Investigate 1 of the following communities and create an interactive poster showing how water is a marker of their identity. Choose from:

- kite surfers
- fishermen on the Mekong delta
- abalone divers in Western Australia
- another community to be negotiated with your teacher.

Use the Glogster link at www.cambridge.edu.au/geography7weblinks to create your poster. Explore some examples first to familiarise yourself with the features available. Make sure you include the following elements in your poster:

- a heading
- clear graphics with captions
- key terms
- at least 1 video embedded.

When you have finished you can copy the URL generated and email it to your teacher for checking. If you are doing this, do not forget to make your poster 'public'.

3.3 Living near water

Everybody needs freshwater to live, so whether they live in mountainous areas, arid regions or on the coast, there must be some sort of freshwater supply such as from a river, lake or groundwater. People like the lifestyle, views, homes and activities on offer near the coast.

ACTIVITY 3.5

1 List reasons why people might live near water.

2 Sort the reasons into the following categories: cultural, economic, aesthetic, cultural, spiritual and recreational.

NOTE THIS DOWN

Copy the table below and compare the advantages and disadvantages on living near water.

Living near water	
Advantages	Disadvantages
Easy access to recreational water activities	Increased risk of flooding

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Geographical fact

Many people do not live near water. The World Health Organization estimated in 2010 that 200 million hours are spent each day globally collecting water.

3.4 Water in …

Art

Water can be beautiful to look at. Most people appreciate water views or **riparian** scenes. Some people appreciate the sound of rolling waves or bubbling streams, and find them relaxing. Such **aesthetic values** placed on water often make people want to capture the nature and character of water and subsequently depict these by creative means. Water is often represented in dance and drama by fluid movement or by blue and green hues in oil paintings. 'Sculpture by the Sea' is an annual outdoor exhibition in Sydney between Bondi and Bronte beaches along the coastal walk. It features works of sculpture that draw inspiration from the beautiful **seascapes** that line the coast, and attracts thousands of visitors each year. There is a similar exhibition at Cottesloe, Western Australia.

riparian relating to the banks of or near a river

aesthetic values the valuing or appreciation of something due to its beauty

seascape a view of the sea

Landscape

Representations of water in landscape art or photography are quite common, for example in coastal scenes. Ken Duncan and Steve Parish are well-known Australian photographers who have incorporated water into their pictures of Australian landscapes.

Source 3.40 Denise Pepper and Brooke Zeligman's *Lifesavers*, at 'Sculpture by the Sea', Cottesloe

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Source 3.41 Water in impressionism – Monet's *The grand canal, Venice*

Impressionism

Impressionism was an art movement that began in the 1860s, and remains popular with the general public to this day. Impressionist artists such as Monet, Pissarro and Renoir took inspiration from the world of nature, in particular the rivers and fields of the French countryside. They focused on challenging traditional concepts of colour and light. One of the most famous works of **impressionist art** depicting water is Monet's series Water lilies. Other impressionist artworks such as Monet's *Bathers at La Grenouillere* show scenes of people interacting with water.

impressionist art art characterised by short brush strokes of bright colours that tend to blend together smoothly when the finished piece is viewed from a distance

Expressionism

Expressionist art was developed around the time of World War I and aimed to represent heightened personal feelings and ideas. Water was incorporated into a range of expressionist artworks, but as a rebellion against the tranquil settings often depicted in impressionist artworks. One of the most famous paintings is *The scream* by Edvard Munch, painted in 1893 with part of the inspiration being water – a **fjord** in Norway.

expressionist art an art form that uses distorted forms to create intensity and express heightened emotions

fjord a long narrow inlet with steep sides or cliffs created by glacial activity

Water in Aboriginal art

Water is an important feature in the art of Aboriginal and Torres Strait Islander people, both historically and in contemporary art. Aboriginal art has varied uses – it can tell stories (for example, of the Dreaming, moral tales or for entertainment), and it can function as a language through its use of symbols. Some of the most important symbols of the Dreaming are associated with water, such as the Rainbow Serpent (often shown connected to billabongs, rivers, creeks and other waterways), fish, turtles, dolphins and crocodiles. All these symbols appear regularly in rock art, some of which dates back 40 000 years. Rock art shows us what was important, culturally, mythically or environmentally, to the first inhabitants of Australia, and therefore the constant presence of water or creatures associated with water demonstrates its importance in Aboriginal cultures.

Bark paintings and dot paintings also both often depict waterways and water creatures.

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Aboriginal art uses many symbols to show water because waterholes are imperative for survival in the desert, and so will traditionally appear in art both as places on a sort of map, and to indicate where important or sacred things have occurred.

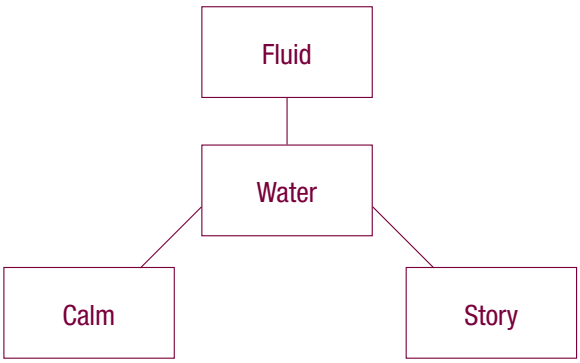
Source 3.42 Aboriginal rock art depicting fish, Kakadu National Park

ACTIVITY 3.6

1. Define impressionist art.
2. Explain how water is depicted in impressionist art.
3. Compare the differences between impressionist and expressionist art.
4. Describe 3 different styles of Aboriginal art.
5. Using the internet, name 2 Aboriginal artists working today who have had exhibitions recently.
6. Discuss the artistic depictions of water you have studied in this chapter as a class. What kinds of qualities in water are the artists trying to convey?

NOTE THIS DOWN

Copy the graphic organiser and examine the different characteristics of water that these works of art display. Water can be many things in many different contexts. Try to note down any extra ideas about water that you came across in your class discussions.



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Literature

Water is such an integral part of life that some people have chosen to write about it or set the scene for plays and novels around it.

Mark Twain

Mark Twain was an American novelist who grew up in a port town called Hannibal on the Mississippi River in Missouri, USA. He wrote the well-known fictional books *The adventures of Tom Sawyer* and *The adventures of Huckleberry Finn*, for which he drew inspiration from his childhood home. The river was a significant part of his identity and writing, as he was also a steamboat captain who studied thousands of kilometres of river.

Tim Winton

Tim Winton is from Perth, Western Australia where he often surfs for a few hours a day. Water plays a significant role in his life and writing. He nearly drowned a number of times, but loves the ocean. He wrote novels such as *Breath*, *An open swimmer* and *Lockie Lenonard: human torpedo*, and a play entitled *Rising water*, all of which incorporate water themes into the storylines. He campaigns for marine conservation – protecting the ocean from overfishing and pollution – and is passionate about the preservation of the Ningaloo Reef off the coast of Western Australia.

Source 3.43 Water plays a significant role in Tim Winton's life and writing.

Judith Wright

Judith Wright was a poet from New South Wales who was well known for her campaigns to support the conservation of the Great Barrier Reef and Fraser Island. In addition to being an **environmentalist**, she was a **social activist**, campaigning for Aboriginal land rights. Water featured in many of her poems such as 'Northern river', 'Drought year' and 'The surfer'.

environmentalist a person who acts to preserve the quality of the natural environment

social activist a person involved in a campaign to promote change, stop change or direct change associated with social issues and policy

The surfer

He thrust his joy against the weight of the sea;
climbed through, slid under those long banks of
foam –
(hawthorn hedges in spring, thorns in the face stinging).
How his brown strength drove through the hollow and coil
of green-through weirs of water!
Muscle of arm thrust down long muscle of water;
and swimming so, went out of sight
where mortal, masterful, frail, the gulls went wheeling
in air as he in water, with delight.
Turn home, the sun goes down; swimmer, turn home.
Last leaf of gold vanishes from the sea-curve.
Take the big roller's shoulder, speed and serve;
come to the long beach home like a gull diving.
For on the sand the grey-wolf sea lies, snarling,
cold twilight wind splits the waves' hair and shows
the bones they worry in their wolf-teeth. O, wind blows
and sea crouches on sand, fawning and mouthing;
drops there and snatches again, drops and again snatches
its broken toys, its whitened pebbles and shells.

Source 3.44 'The surfer', by Judith Wright

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ACTIVITY 3.7

1. Identify 3 authors who have written about or interacted with water.
2. Explain the significance of water to Tim Winton.
3. Read Judith Wright's poem, 'The surfer' (Source 3.44) and think about how water is represented. Then create a list of your own adjectives, metaphors or similes for water.
4. Compose your own poem about interactions with water. This might be from another person's perspective – a fisherman, a tourist operator, a scuba diver or a lifeguard.

Religion

Water plays an important role in most religions. It is usually used for ritual washing to purify the body or wash away wrongdoings before presenting oneself to a holy being.

Buddhism

In Vajrayana Buddhist tradition it is customary to offer 7 bowls in front of the altar. Among bowls offering fruit and flowers, water for drinking and water for washing are offered in separate bowls. This practice is common in Tibet and Bhutan, where you can also see spinning prayer wheels and coloured prayer flags.

Source 3.45 Buddhist water bowls

Christianity

In the Christian religion, a **baptism** with holy water indicates a person's commitment to the faith. It is also used to christen infants and dedicate them to Jesus Christ. Depending on the church, some people will be fully or partially immersed in water to signify new beginnings and purification.

baptism a ceremony purifying the spirit through contact with holy water

RESEARCH 3.5

Investigate the use of water in 2 religions and cultures not discussed in this chapter. Identify common themes and uses for water. Compare how water contributes to identity in the different situations you have researched. Present your findings in a PowerPoint presentation.

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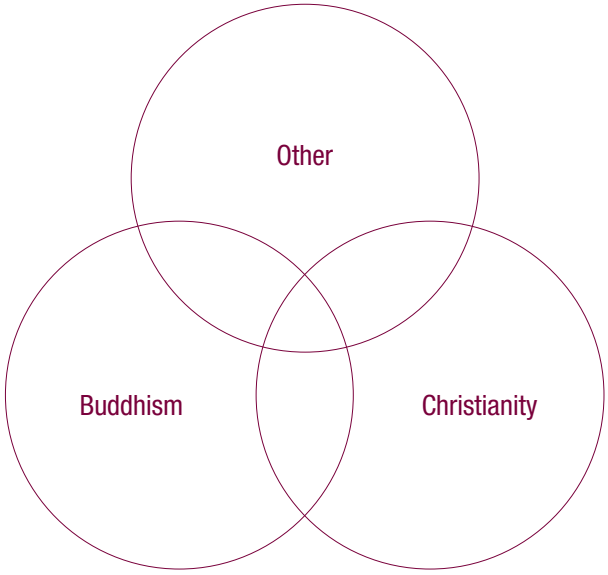
NOTE THIS DOWN

Copy and complete the graphic organiser below, comparing the use of water in Buddhism and Christianity and a religion you investigated in Research 3.5.



Healing

hydrotherapy treatment to manage pain and increase movement of the body via the use of water and gentle exercises while immersed

Water has been used in conjunction with modern medicine to heal people. **Hydrotherapy** is a form of physiotherapy to help rehabilitation and recovery from injury. Sometimes the water is heated to stimulate blood flow and muscle activity. Exercising in water provides supported resistance to work against and build strength.

ACTIVITY 3.8

1. Outline the significance of water in religion.
2. Describe how water is used in Buddhism, Christianity and Hinduism.
3. Explain how water is used to help people recover from injury. Can you think of any other ways water is used to heal people?

Sport

recreational value the emphasis people place on something in terms of its leisure purposes and enjoyment

Numerous sports revolve around water. Some are simply for **recreational value**, but at elite levels each has specific requirements for optimal conditions.

Swimming is a popular sport in Australia – both recreational swimming at the beach and competition swimming in a 50 m pool. For Olympians, the water quality is important for peak performance. Specific requirements about temperature, chlorination, elim-

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Source 3.46 Rowers on the still waters of the Yarra River in the early morning, Melbourne

inating bacteria and monitoring water quality were in place at the Olympic Games in Beijing in 2008.

Rowers usually rise early in the morning to capitalise on the smooth, calm water that develops overnight. Scullers, oarsmen and oarswomen need these conditions – their vessels are lightweight and sit low in the water, and shouldn't catch the blades on peaks in the water, as this will unbalance the boat. At an elite level, special rowing courses, such as the Nepean rowing course in Penrith, Sydney, have been constructed to minimise wind and disturbance to the water surface.

On the other hand, windsurfers like the choppier conditions where wind has whipped up waves. They use the waves as a jump-off point, as well as to perform tricks or gather speed. A popular spot to windsurf is Inverloch, Victoria.

Music

Water has provided inspiration for some musicians and recording artists. For example, in 1717 Handel composed a range of orchestral pieces entitled *Water music* for King George I. In addition, some people buy and listen to music tracks that play the soothing sounds of streams or waves accompanied by flutes for relaxation.

Music often uses water as a poetic idea as well. A famous example is *Die Moldau* (or *The Moldau*) by the Czech composer Bedrich Smetana, which evokes the sounds of a Bohemian river. Composers in the twentieth century have also written music that depicts water in ways similar to those of the impressionist painters, such as the piano piece 'Jeux d'eau' ('Water games') by Maurice Ravel, and *Four sea interludes* by Benjamin Britten.

Geographical fact

The Australian Bureau of Statistics in 2007 found that the Northern Territory has the highest proportion of households with swimming pools in Australia (29%) compared to other states and territories.

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ACTIVITY 3.9

Listen to 1 of the musical works referred to in the section above, such as the first of Britten's *Four sea interludes*, and answer the following questions.

1 What sorts of images does the music conjure up?

2 Describe what kinds of natural water sounds the instruments evoke.

RESEARCH 3.6

Investigate how water is represented in music and use the information you find to help you compose your own soundtrack. You can use GarageBand or Audacity or online facilities like SoundCloud for recording different sounds associated with water, and then add other musical layers, such as a background beat or other sounds you like. Ideas for what you might record include:

- a tap dripping
- noise at a swimming pool
- a stream or creek
- waves crashing against rock
- ripples lapping at the shores of a lake.

3.5 Water as an investment

People often want to live close to water for a variety of reasons, including access to work via ferry, lifestyle on the weekends, the picturesque views and prestige. Living or operating businesses near freshwater rivers and saltwater oceans is popular because people get a financial return for their water-related activity, although at times this has been at the cost of environmental deterioration.

economic value a dollar amount placed on an asset to show how much it is worth

Even though water may have no **economic value**, it is crucial to acknowledge the exploitation of water by societies as they seek to gain greater profits for various activities.

Oceans

Coastal dwellings are very much in demand and often fetch higher house prices compared to similar homes inland. To purchase a house with ocean views therefore requires significant amounts of money. Often people will purchase dwellings in beachside suburbs such as Avoca and Terrigal in New South Wales as an **investment**, and then lease them to other families for their beach holidays.

investment spending money on something for a financial reward or return

Geographical fact

Nearly half the world's population lives within 100 km of the coast.

Rivers

Some businesses need to be established near rivers because they use them to transport goods. For example, the Huangpu River in China has a constant flow of barges transporting materials to and from the world's busiest container port, Shanghai.

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The Snowy Mountains Hydro-Electric Scheme in New South Wales is a dual-purpose operation whose success is entirely dependent on close proximity to the Snowy River. It was a major engineering feat that took 25 years to build and was completed in 1974. The scheme generates electricity for the Australian Capital Territory, New South Wales and Victoria and also helps irrigate farmland in western New South Wales. Investment in this project by the government of the day required the 16 dams, 7 power stations and many kilometres of aqueducts to be built in close proximity to the water supply. Currently, Snowy Hydro is a company owned by 3 states that manage the energy resources generated, but there is significant pressure for New South Wales to sell its share so that the money can be invested elsewhere.

3.6 Conservation of water

The water cycle is a closed system. This means that the world neither gains nor loses water – it just changes form and location. Every life is dependent on water, so **environmental conservation** of water is vital to ensuring human survival. In order to provide an ample supply of freshwater, societies construct dams along surrounding river systems. This causes significant disruption to natural environments but also provides great advantages to society. Managing this water supply is critical in times of drought.

environmental conservation preserving and restoring the environment to ensure no further degradation

Geographical fact

Using the dishwasher is more water-efficient than washing up in the sink, especially if the dishwasher is full!

ACTIVITY 3.10

1. Define the term 'investment'.
2. Why do people want to live near oceans?
3. Analyse the use of rivers for economic purposes.
4. Demonstrate the need to conserve water through a role-play.
5. Creative writing task: imagine you are a drop of water. Where do you go? What do you do? What do you see? How do you interact with people, plants and animals?

RESEARCH 3.7

Investigate the use and cultural significance of a major river such as the Nile, the Rhine, the Yangtze or the Mekong. Critically analyse the significance of the river for local people. Present your findings to the class in the form of a visual display or electronic presentation. You must include the following:

- cultural value of the river
- economic value of the river
- aesthetic value of the river
- recreational value of the river
- how the river contributes to the identity of local people
- spiritual significance of the river (if applicable).

ISBN 978-1-107-69012-7

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Case study 3.3
The Ganges – a holy river

The Ganges in India is considered by the Hindus to be the most holy river. Bathing in its holy water is a key part of their religion. Millions of Hindus travel long distances on pilgrimages to towns along the river to bathe using ***ghats***, particularly in Varanasi. Here the elderly and the sick also spend their last days praying and being spiritually cleansed. The Ganges is significant for other Indian festivals, too. Petals and candles are sent downstream during the 5-day Ganga Mahotsav festival that celebrates Varanasi as the cultural capital of India. Ganges means 'river', from the Hindu '*ganga*'.

ghats steps leading down a river

People drink the holy water and take containers of it with them to nearby temples and ***ashrams***. Water plays a significant part in Hindu life and also in death. The body of a recently deceased Hindu will be laid on sandalwood logs and set alight before being sent down the river. The burning funeral pyre and scattering of ashes in the Ganges fulfils part of the *samskara* (cycle of successive lives). The clean, milky-coloured river runs fast near the source and through mountains above Rishikesh, but closer to the mouth the currents are slower as the water reaches flatter ground. Approximately 400 million people rely directly on the Ganges, and live close to it. It provides water to about 40% of India's population, but the water quality is extremely poor due to the large amounts of rubbish, industrial waste, faeces and silt collected and transported downstream. It is also used for cooking and washing clothes, causing severe health problems including dysentery, cholera and diarrhoea. Numerous attempts have been made to clean up the Ganges, but it remains among the top 5 most polluted rivers in the world.

ashram a community where people (mainly Hindus) practise yoga, meditation and other spiritual activities

1. Name the holy town on the banks of the Ganges.
2. List 4 ways in which people use the Ganges.
3. Why is the Ganges significant to Hindus?
4. Describe the differences in pollution levels between the source and the mouth of the Ganges.
5. Explain how polluted water in the Ganges effects the population.

Source 3.47 Varanasi *ghats*, on the west bank of the Ganges, Uttar Pradesh state, north India

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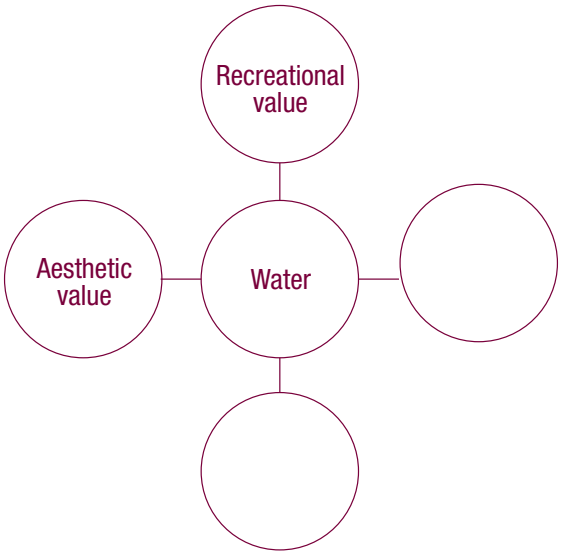
NOTE THIS DOWN

Copy and complete the graphic organiser below and show how water makes people feel by drawing relationships between elements.



FIELDWORK 3.2 WATER IN MY WORLD

Aim

To visually represent the variety of ways water is used and how it contributes to people's sense of identity.

Method

Use observations and photographs to create a photo essay.

Preparations

You will need:

- a camera or mobile phone camera
- a map of your local area – highlight the route you wish to take and make sure you check with your parents before you head off
- a pen or pencil.

Data collection

Take photos of all the different interactions with water that you notice. Mark the site of each photo on your map for future reference and jot down a 1-sentence caption describing what is taking place in the picture. Examples of some situations you may come across could be:

- water at a place of worship
- water in sport
- water in homes and businesses
- people living with and near water.

Fieldwork presentation

Use a presentation tool such as PowerPoint, Keynote or Prezi and include a caption for each photo. Features of photo essays should include:

- planned or spontaneous shots that are interesting
- photos that show interactions between people or things
- a series of photos that tell a story.

You could select appropriate music associated with water or with 'water' in the lyrics to make your presentation more engaging.

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Chapter summary

- Water is used for various purposes, such as farming, transport, fishing, recreation, tourism and health.
- Waterways, such as seas, bays and rivers, have enabled the exploration of new lands, the establishment of human civilisations and the continued globalisation of trade.
- People have for thousands of years found ways of accessing and using water resources (surface water and groundwater) to farm the land.
- Water is harnessed for energy production in various locations throughout the world.
- The use of water, for example from largely non-renewable groundwater sources (fossil aquifers), often has both positive and negative impacts on people and the environment, as well as influencing the sustainability of its supply.
- Water is a marker of identity. Different people use and interact with water in different ways, such as river people, surfers, islanders and boaties.
- Water is often used as a subject in the visual and performing arts, such as in impressionist painting or Aboriginal art.
- Water has been represented in literature by many writers. Author Tim Winton lives in Fremantle, Western Australia, is a keen surfer and often includes water or coastal themes in his writing.
- Water plays a role in most religions, usually representing cleansing or purity. For example, baptisms in Christianity signify a new beginning for people.
- Water sports can be recreational or competitive. At elite levels in the Olympics, certain standards are required for water conditions and quality for sports such as rowing and swimming.
- Many people live and conduct activities on properties near water because it is an investment from which they can expect a financial return – for example, a house on the coast, shipping lanes in major rivers and hydroelectricity generators.

End-of-chapter questions

Multiple choice

1 Australia's largest port is:

A Sydney Harbour
B Port Augusta
C Port Phillip Bay
D Fremantle Harbour

2 Which of the following irrigation methods is generally the most water-efficient?

A Flood
B Drip
C Sprinkler
D Furrow

3 The Trevi Fountain in Rome was supplied with water from:

A an underground aqueduct
B the city's main water storage dam
C one of Italy's major rivers
D an above-ground aquifer

4 What proportion of the world's population lives within 100 km of the coast?

A 80%
B 70%
C 60%
D 50%

ISBN 978-1-107-69012-7

Cambridge University Press

5 What is the name given to the practice of treating injuries using exercises in the water?

A Aromatherapy

B Hydrotherapy

C Naturopathy

D Physiotherapy

Short answer

1 Which civilisations were the first to control water flow? Describe how they achieved this and the impact it had on the region.

2 Examine the main differences in the use of water for rice farms in the Murray–Darling Basin as compared with rice terraces in South-East Asia.

3 Which of the following uses a more renewable source of water – desalination plants in Saudi Arabia or the Great Man-Made River Project in Libya? Substantiate your choice.

4 Analyse how water is represented in art and literature.

5 List reasons why proximity to water is seen as desirable.

Extended response

Evaluate the value of water for people. In your response, you must:

- refer to a range of subcultures or communities
- include quotes, facts and statistics where appropriate
- use geographical terms and concepts.

Source 3.48 The Murray River near Mildura, Victoria

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4 Managing water

Source 4.1 Women carrying water in an Indian village

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Before you start

Main focus

Water is a vital resource for all living things, but its limited supply means it can be difficult to manage, leading to issues with its supply and demand all over the world.

Why it's relevant to us

Water scarcity affects people's lives in different ways and it is important to look at how our actions now can ensure water security into the future.

Inquiry questions

- Why are water resources so difficult to manage?
- What issues affect the management of water resources in Australia and other parts of the world?
- How can we reduce our water use and find other sources of water?

Key terms

- Catchment
- Conflict
- Desalination
- Economic water scarcity
- Integrated catchment management
- Physical water scarcity
- Water recycling
- Water scarcity

Let's begin

Water is a vital resource for all living things, but it is in limited supply. Water resources are difficult to manage and this issue is particularly important in Australia as well as in other parts of the world. As the world's population continues to grow at a rapid rate, the demand for water, and the way we manage it, are becoming increasingly important issues. A safe, sustainable water supply allows populations to stay healthy and develop economically, while ensuring that enough water is left in rivers and lakes to support animals and plants.

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4.1 The difficulty of managing water

In Australia, many of us do not spend time worrying about where we get our water from. We turn on the tap to get water to drink, jump into the shower to wash ourselves, and use water from a hosepipe to wash our car or water our garden. But in other countries people are not so lucky. In developing nations, water is in short supply and must be collected daily. Even in Australia, managing water is a difficult balancing act. How do we ensure there is enough water for us to drink, for farmers to grow crops and for industry to make products, while ensuring there is enough to keep our rivers and lakes healthy?

urbanised having a higher proportion of people living in towns and cities than in rural areas

As countries become increasingly **urbanised**, the management of water becomes even more difficult. Issues such as pollution of water supplies and flooding also need to be considered when managing water, as well as how to secure future supplies as urban areas expand.

Water supply

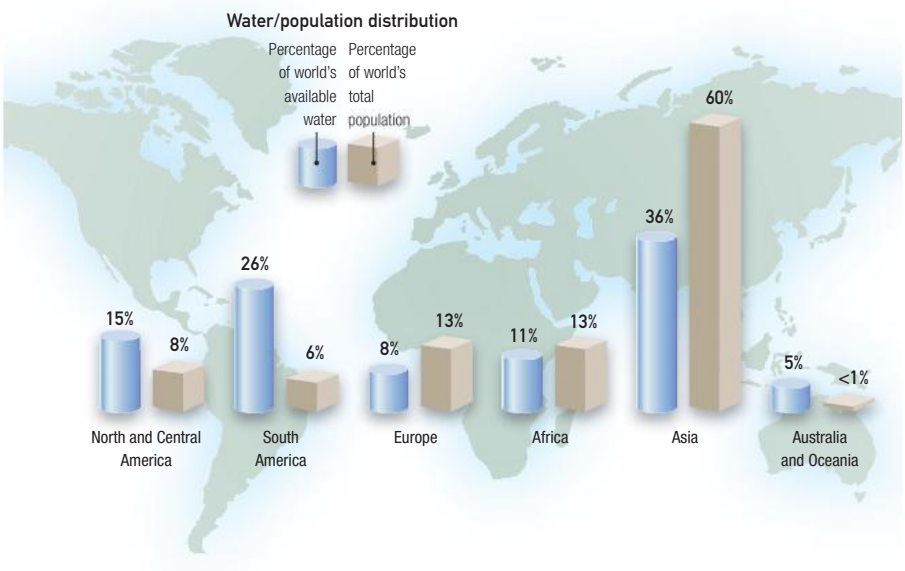
It is estimated that a human needs around 1000 m^3 of water a year to drink, grow food and meet basic hygiene needs. On this basis we have easily enough water to go round from our accessible freshwater supplies. The problem lies in the following factors:

- This water is not always available all year round.
- The water is often located far away from where the population lives.
- Many people mismanage, pollute or overuse their water supply.

Source 4.2 shows how many regions of the world have more people living in them compared to their proportion of the world's available water. As regions such as Africa and Asia continue to experience population growth, this gap may continue to widen in the future. Other regions such as South America have far more water than they need. Some of these countries are now looking to export their water to regions that need to increase their supply.

Geographical fact

Did you know that women worldwide spend 200 million work hours a day collecting water for their families? This is the equivalent of building 28 Empire State Buildings every day.



Source 4.2 Comparing the percentage of water availability with the percentage of world population

ISBN 978-1-107-69012-7

Cambridge University Press

Source 4.3 Economic water scarcity: people filling drinking water from a tanker, Chennai, Tamil Nadu, India

Source 4.4 Water restrictions in action outside Melbourne's Exhibition Building

Water scarcity

water scarcity a situation in which there is insufficient water to maintain current standards of living

economic water scarcity a situation in which a place has adequate local supplies to meet its water needs, but lacks money to create the infrastructure for the population to access safe drinking water

physical water scarcity a situation in which a place lacks local supplies of water to sustain current standards of living

Water scarcity currently affects around 1.2 billion people worldwide, in every continent. There are 2 types of water scarcity: **economic water scarcity** and **physical water scarcity**.

Causes of water scarcity

Water scarcity is caused by a wide range of human and natural factors. Increased populations, inefficient farming techniques, droughts, climate change, overuse of water for industrial and domestic use, poverty and a lack of infrastructure can all lead to water scarcity occurring.

Dry areas suffer from water scarcity only if there are people living there requiring water. The point at which water scarcity occurs differs between places as the amount of water required to maintain standards of living also varies. So an irrigated farming region in Australia may use a lot of water and suffer from water scarcity, even though it may have much more water available than a North African farming village.

ACTIVITY 4.1

1 Describe 3 uses of water that need to be balanced when thinking about the management of water as a resource.

2 Examine the photograph taken in Chennai, India (Source 4.3). Imagine you are living in the region and write 2 paragraphs describing how this lack of piped water would affect your life.

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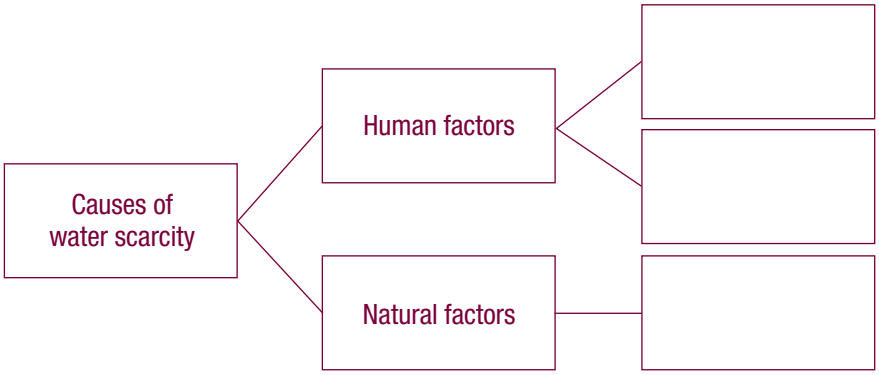
NOTE THIS DOWN

Copy the graphic organiser below and categorise the causes of water scarcity as human or natural factors.



4.2 The effects of water scarcity

Water scarcity can have severe effects on the quality of life for people, in both more developed and developing parts of the world.

Health

A lack of water can have severe impacts on the health of a population. While extreme cases of water shortage may lead to dehydration and even death, prolonged periods of drought can lead to a lack of food and malnutrition. This is particularly likely to happen in developing countries where people are reliant on growing their own food supply.

Source 4.5 Children in Zambia collect water from a communal tap.

Geographical fact

Water scarcity increases the chance of people catching waterborne diseases such as cholera because unsafe water supplies may be accessed through desperation. Cholera kills around 150 000 people every year.

Employment

Rural populations experiencing water scarcity are particularly vulnerable to losing their jobs as a lack of water may reduce the level of agriculture in a region. Many other industries such as mining and manufacturing are also reliant on water, and may be forced to close down if water supplies dry up.

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Lifestyle

Water scarcity may mean that certain aspects of everyday life have to be sacrificed. Showers may be restricted, gardens may die as a result of water restrictions, and activities based on rivers and lakes or at swimming pools may not be possible. Water bills may go up, putting financial pressure on families.

In less-developed countries people may be forced to walk for many kilometres to collect water. Money that could be spent on other things may have to be spent on buying bottled water to ensure a safe water supply.

Case study 4.1

Water scarcity in Egypt, North Africa

North Africa is among the driest regions in the world, with much of its area made up of sparsely populated desert. Populous Egypt is home to 82 million people and water scarcity is becoming a serious problem as the population is increasing by 1.4 million people each year. The country has traditionally claimed most of the water found in the Nile River for drinking and irrigation to grow food. Traditional methods of irrigation wasted large amounts of water through evaporation and leakage. The water also became increasingly **saline**, which has damaged the land. In desperation many farmers are feeding livestock and watering crops with a mix of water and untreated sewage, threatening the health of the local population.

saline having high levels of salt

In recent years, the water from the Nile River has been under threat as other countries upstream make a claim for the water to support their growing populations. Tension with bordering Sudan has increased over the issue of water security.

Egypt's capital city, Cairo, is also struggling to provide adequate, safe water as the city expands. Much of the growth is occurring in slum areas, where a lack of sanitation is polluting existing water supplies. In 2010 residents rioted over the lack of clean water in the city.

Egypt has responded by trying to educate its population about water saving, introducing modern irrigation techniques and recycling water. Despite these steps, some scientists have predicted Egypt will run out of water by 2025.

1. List 3 reasons why Egypt is suffering from water scarcity.
2. Analyse the effects of water scarcity in Egypt.
3. Explain whether you think Egypt is suffering from physical water scarcity, economic water scarcity, or both.

Source 4.6 Inefficient irrigation techniques in Western Egypt

Source 4.7 Authorities struggle to provide clean water to Cairo's expanding population.

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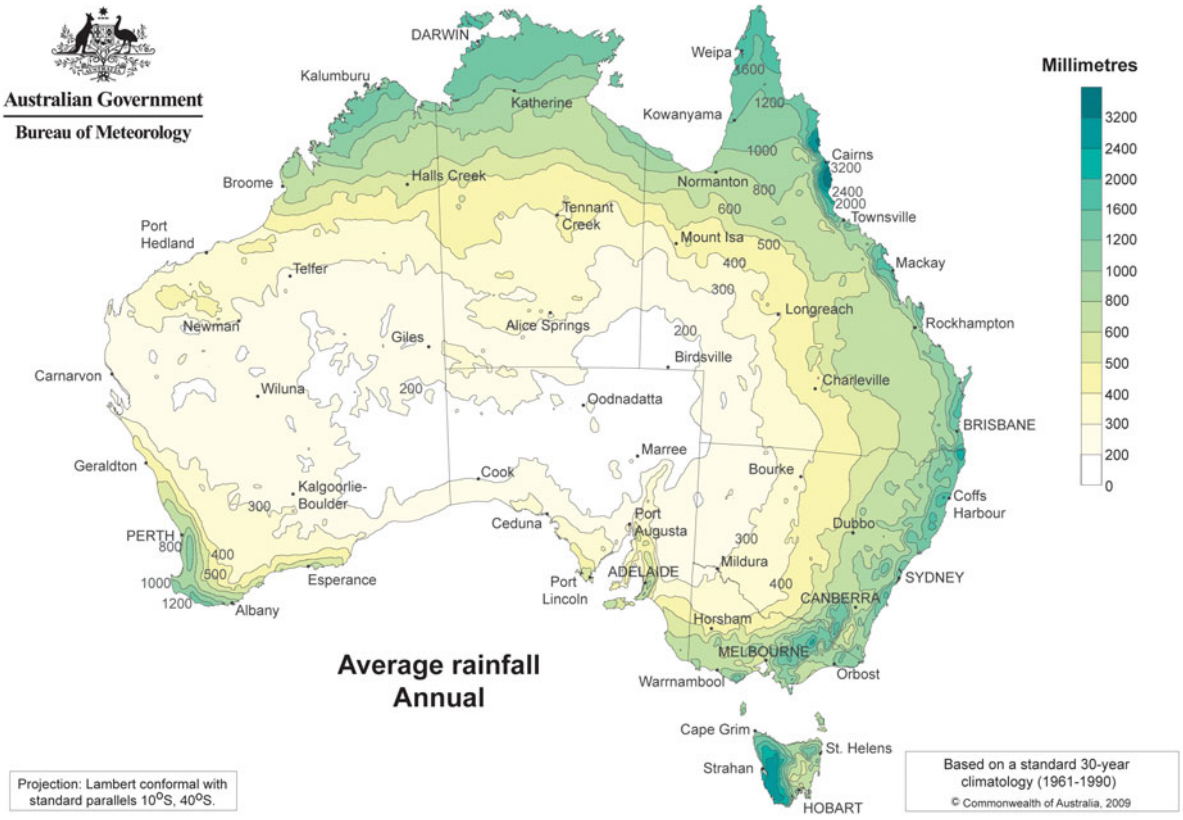
Water scarcity in Australia

Australia is the driest inhabited continent on Earth. As Source 4.8 shows, around 70% of the country receives less than 500 mm of rain each year. This has resulted in most of the nation's population being located in the wetter regions to the south and west of Australia. However, even some of these areas are under threat from water scarcity, particularly in times of drought. Central Australia has a low population so, although rainfall levels are low, there is almost no need for water, and water scarcity is not occurring.



Source 4.8 Annual rainfall distribution (mm)

Case study 4.2

Water scarcity in the Murray–Darling Basin

The Murray–Darling Basin covers about 14% of Australia and provides drinking water for almost 3 million residents. The area is also an extremely important region for agriculture, producing 45% of Australia's farming output, much of it through **irrigation**. It is also an important region for tourism and recreational activities based around the river.

All of these uses have taken vast amounts of water out of the river, and in times of drought the system comes under severe pressure from a lack of **environmental flow**.

irrigation watering of crops

environmental flow the amount of water required to maintain river health

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This is threatening the 35 endangered species that live in and around the river and the thousands of wetlands that are found along its course.

Causes
Over-extraction of water
Inefficient irrigation practices
Unsuitable crops
Lack of communication between states

Effects
Habitats destroyed by a lack of water
High salinity leading to poor water quality
Farms and communities affected
Drinking water supplies under threat

Many have argued that the river has been badly managed, and that some states have withdrawn too much water, causing problems for the states downstream. There are also concerns that crops such as rice and cotton, which use lots of water, are not suitable for the region.

In recent years, high rainfall and floods have reduced the effects of previous droughts, but experts believe the river system is still under threat unless major changes are made.

Possible solutions include:

- reducing the water extracted from the river by 40%
- introducing more efficient irrigation techniques such as drippers to all farms
- piping water from tropical Queensland into the Darling River.

The issue of managing the Murray–Darling is extremely complex, as the river crosses a number of state boundaries. This means it is hard to reach agreements regarding practices downstream without first securing agreements upstream, where the water may already be being used for economic benefit. The solutions outlined above can work only with full agreements from all states in the basin.

1 Identify the uses and activities that have led to vast amounts of water being taken out of the Murray–Darling Basin.
2 Describe a cause and effect of water scarcity on the river.
3 Explain why the issue of managing the river is so complex.

Source 4.9 The Murray River showing the effects of prolonged drought

Source 4.10 Techniques being adopted to improve water efficiency near Echuca, Victoria

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RESEARCH 4.1

Create an A3 poster on the issues the Murray–Darling Basin is facing. Your poster should include the following:

- the location of the Murray–Darling Basin
- an explanation as to why the area is facing water scarcity
- the social, economic and environmental effects of water scarcity in the region
- a description of 1 response to the problems of water scarcity in the region.

Conflict over water

Conflict over water occurs for the following reasons:

Increased demand for water + Water supplies running out + Unequal or differing uses for water = Conflict over water

Conflicts over water are particularly common where rivers flow over state or national borders, and in regions where water scarcity occurs. Water conflict may also occur when supplies of water are threatened, or when the price of water may increase.

Geographical fact

The Nile River Basin is spread through 10 countries in Africa, the 3 most populated being Egypt, Ethiopia and Sudan.

We have already seen in this chapter that Egypt is suffering from extreme water scarcity. Egypt's reliance on the Nile River means it is currently allocated 75% of all water from the river. Sudan receives the other 25%.

Ethiopia, which is the source for much of the water that flows into the Nile, receives no water from the river.

Source 4.11 An aerial photo of the Nile River Basin

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4.3 Water management strategies

Traditional solutions to water scarcity

Dams

Since European settlement, dams have been one of the main sources of water for Australia's rural and urban areas.

A dam works by blocking off a river valley with a large concrete wall. The area behind the wall is then flooded, creating a lake and storage site for large quantities of water. Smaller dams are often constructed on farms to catch and store rainfall as it runs off the land.

As well as providing water for drinking and irrigation, dams can also be used to prevent flooding and generate electricity. Dam projects often employ lots of people in local areas in their construction.

Geographical fact

It has been estimated that the construction of the Three Gorges Dam in China will employ 26 000 people.

Source 4.12 When completed in 1907, the Cataract Dam in New South Wales was the fourth largest dam in the world.

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Dams can, however, create a wide range of problems for both the natural and human environments. When a large area behind a dam is filled with water, any habitats, farmlands or even human settlements are likely to be flooded. People may be required to relocate from their homes. With little natural flow, such lakes may suffer from **algal blooms**.

algal bloom the build-up of algae that can destroy ecosystems

Downstream, dammed rivers can be affected by a lack of environmental flow and fish may struggle to migrate past the dam to feeding grounds where they reproduce. **Sediment** that would usually travel to the coast to form beaches is trapped, increasing the risk of coastal erosion and flooding.

sediment material eroded from the land and river banks by water and deposited elsewhere

Source 4.13 Algal blooms in the Baltic sea

NOTE THIS DOWN

Copy and complete the table below and explore the advantages and disadvantages of dams from an environmental, social and economic perspective.

Dams					
Environmental		Social		Economic	
Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
Prevents flooding	Affects the river's ecosystem				

Diverting water

Transporting water from locations with high levels of rainfall to areas suffering from water scarcity is another way of providing freshwater to those in need. This occurs through the construction of pipelines and canals, and by diverting rivers.

South Australia, as the driest state in Australia, has large areas that suffer from water scarcity. In dry years, up to 90% of the state's water is transported from the River Murray through a series of pipes. The longest of these pipelines is 325 km, stretching from Morgan on the River Murray to Whyalla in the west of the state. While these pipelines have successfully provided water for over 50 years, and have allowed for the development of areas of South Australia that would not have been possible

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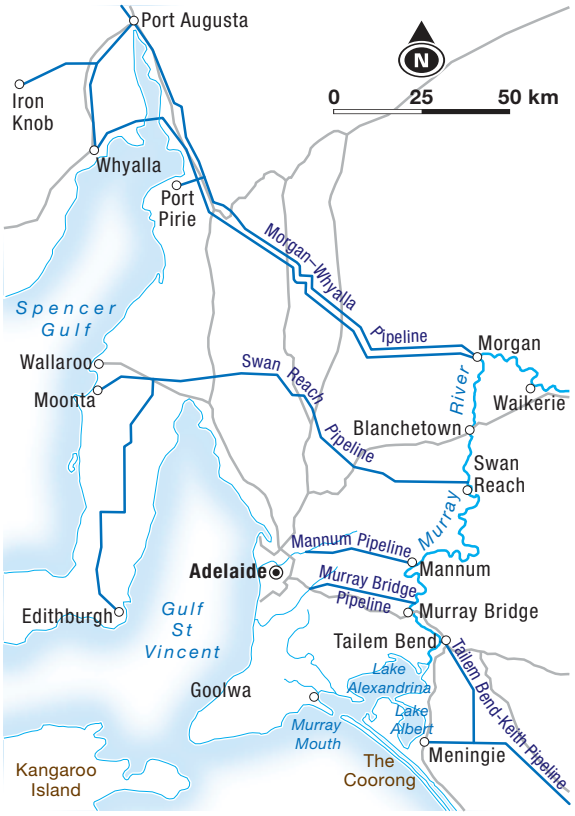
without this supply of water, they are expensive to maintain and have been at risk of failing when the river level has been low.

In Israel, another extremely dry area, a national scheme was set up to transport water from the Sea of Galilee in the north to irrigate and supply drinking water to the arid regions to the south. Up to 1.7 million m^3 a day flow through the system, allowing farmers to grow a range of crops in heavily irrigated fields.



Source 4.14 Water pipelines in South Australia

Source 4.15 The River Jordan in drought as a result of water diversion

Source 4.16 Irrigated areas in central Israel

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Unfortunately, however, the diversion of water from the sea, along with other diversions in Syria and Jordan, has caused the River Jordan, which feeds into the Sea of Galilee, to experience severe environmental damage.

Environmental flows are at 2% of what they were prior to the construction of the scheme, and large areas of the river have lost rare species of fish and birds that previously lived there. Continued conflict between Israel, Palestine and Jordan has made management of this problem even more difficult.

NOTE THIS DOWN

Copy and complete the table below, answer the questions and summarise what you have learned about diverting water.

Why are people diverting water?	How are they diverting water?	What are the impacts on the areas from which water is being diverted?	What are the impacts on the areas to which water is being diverted?

Alternative approaches to water scarcity

Desalination

As water supplies continue to be depleted around the world, many are looking for alternative ways to create freshwater. An increasingly popular method is by turning seawater into freshwater, through a process called desalination. This has been widely used across the world, particularly in dry regions such as the Middle East. Other heavily populated regions in countries such as Japan use desalination plants to cater for large numbers of people.

Geographical fact

Australia's desalination plants can produce enough water to fill over 500 Olympic-sized swimming pools every day.

Desalination plants

Desalination plants are a particularly popular option with governments because they:

- provide a reliable source of drinking water
- are not reliant on rainfall
- are located in coastal locations, which are usually where the population is concentrated
- have produced water with a taste that the public has found acceptable
- provide employment in the construction and maintenance of desalination plants.

Australia now has 7 desalination plants in use, in progress or planned, providing water for urban centres in all the mainland states.

While major desalination plants are securing water for the major urban centres, the same technology is also being used in remote communities across Australia to provide clean and reliable drinking water. These systems are used when bore water is too salty to drink. Similar systems are also on remote resort islands, cruise ships and submarines.

Despite the importance of desalination as a source of drinking water, it is still a somewhat

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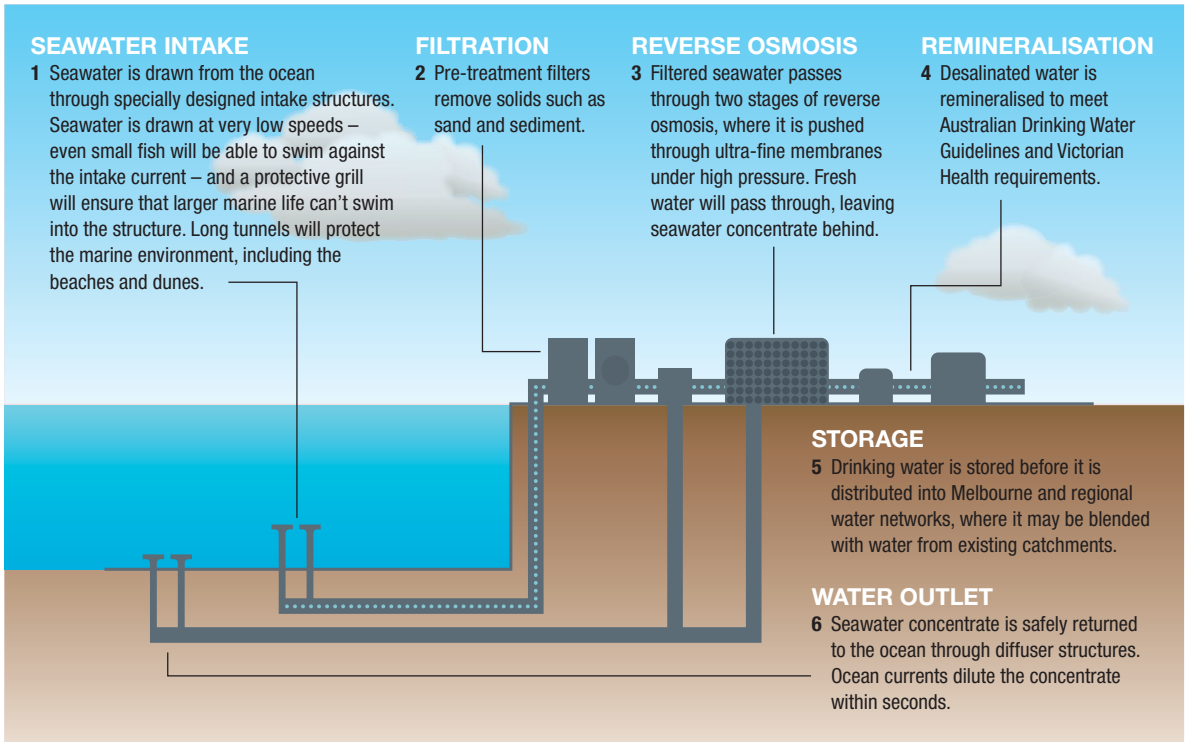

Source 4.17 How a desalination plant works

Source 4.18 The Port Stanvac Desalination Plant, also known as the Adelaide Desalination Plant, in South Australia

controversial choice. It is extremely expensive, and Australia's major plants cost between $1 billion and $3.5 billion to build. These costs are then passed on to the public through increased water bills. Many plants have been built at huge expense, only to be 'mothballed' – turned off until they are required.

The plants also use huge amounts of energy, creating greenhouse gases when powered by fossil fuels. Perth's desalination plant has its own wind farm, located to the north of the city, but it and other cities are also reliant on coal- and gas-fired power stations.

One of the biggest concerns involves the pumping of concentrated salt back into the oceans. Without careful monitoring and planning, the high levels of salt found near desalination pipes can damage marine ecosystems. To avoid this problem, plants are constructed in areas of deeper water with strong tides to disperse the water that is high in salt.

Also, because desalination plants are often needed only in times of drought, the desalination plant in the Gold Coast has been put on stand-by until it is needed sometime in the future.

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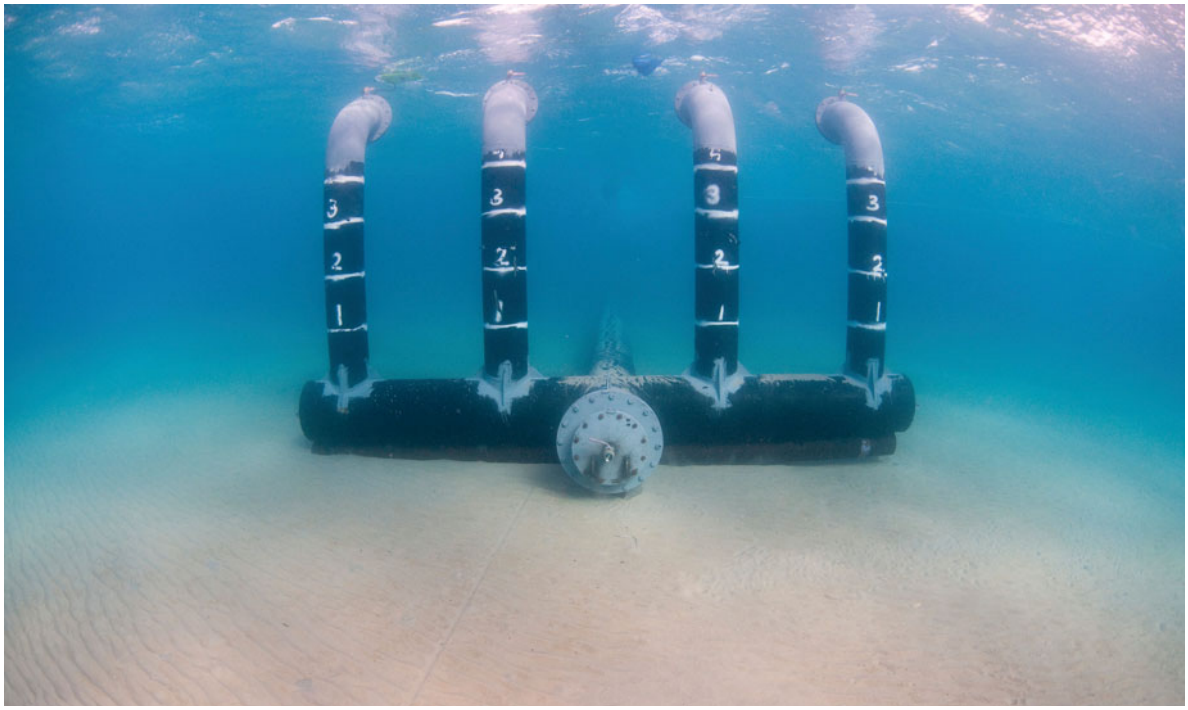

Source 4.19 Brine distributed into the ocean can have damaging effects on marine life.

ACTIVITY 4.2

1. Provide 2 reasons why desalination plants are being built. Why may they be a more reliable method of supplying water than dams or diverting water?
2. Explain 2 different ways desalination plants can have negative environmental impacts and 2 ways these impacts can be minimised.
3. Research a desalination plant in Australia and answer the following:
   - **a** Where is it located?
   - **b** Why was it constructed?
   - **c** How much water does it produce?
   - **d** Have there been any concerns or negative impacts?
   - **e** Is the construction of this desalination plant a good decision or not?

Recycling water

Another option when addressing shortages of clean water involves the recycling of water that has already been used for another purpose. Examples of previously used water may include water used in our houses or industry, treated sewage, or water that has washed down our streets or through our drains. There are several different ways in which this water can be treated.

Drinking recycled water

All water can, essentially, be cleaned and treated to make it safe for drinking. In many European and Asian countries a considerable amount of drinking water comes from sources partly composed of treated sewage. In Australia this is far less common, although recycled water is used for a range of other purposes, depending on the method of treatment.

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Geographical fact

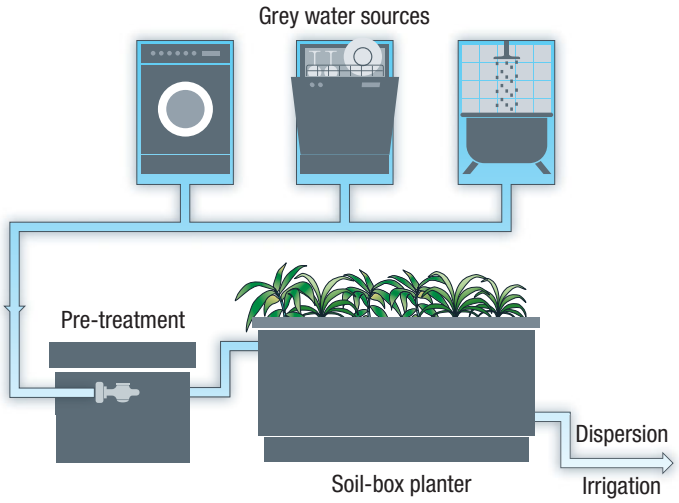
It is estimated that a glass of drinking water in London has been through 7 other people before you drink it!

Using grey water

Grey water is produced by every household. It is the water from showers, washing machines and sinks (but not toilets!) that would otherwise go down the drains. Grey water use may be as simple as having a bucket in the shower to collect excess water and then using that water on your garden.

More sophisticated systems can pipe all this water directly into your garden to irrigate lawns and pipes. You can also buy advanced systems that will treat the grey water, making it suitable to flush toilets with, or to use in washing machines or dishwashers.

Grey water cannot be drunk, and certain soaps and detergents may not be suitable for use in it, but extensive use of grey water can save a household up to 50 000 litres of water per year.



Source 4.20 Grey water system for home use

Treated effluent and sewage

Wastewater treatment plants across the world use a range of steps to clean human waste. In many cases this treated water is pumped out to sea, but increasingly it is being used for irrigation, industry and other non-drinking applications. This reduces pressure on sources of water that are safe to drink. It also provides a regular supply of water that is not reliant on the rain. In Singapore, 30% of drinking water comes directly from raw sewage; technology similar to that in desalination plants is used to make it safe.

Source 4.21 A plant distributing treated effluent for use on crops

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Many people, however, are uncomfortable with the idea of drinking raw sewage. In Toowoomba in Queensland, a scheme to introduce drinkable recycled water from waste was rejected by 62% of residents.

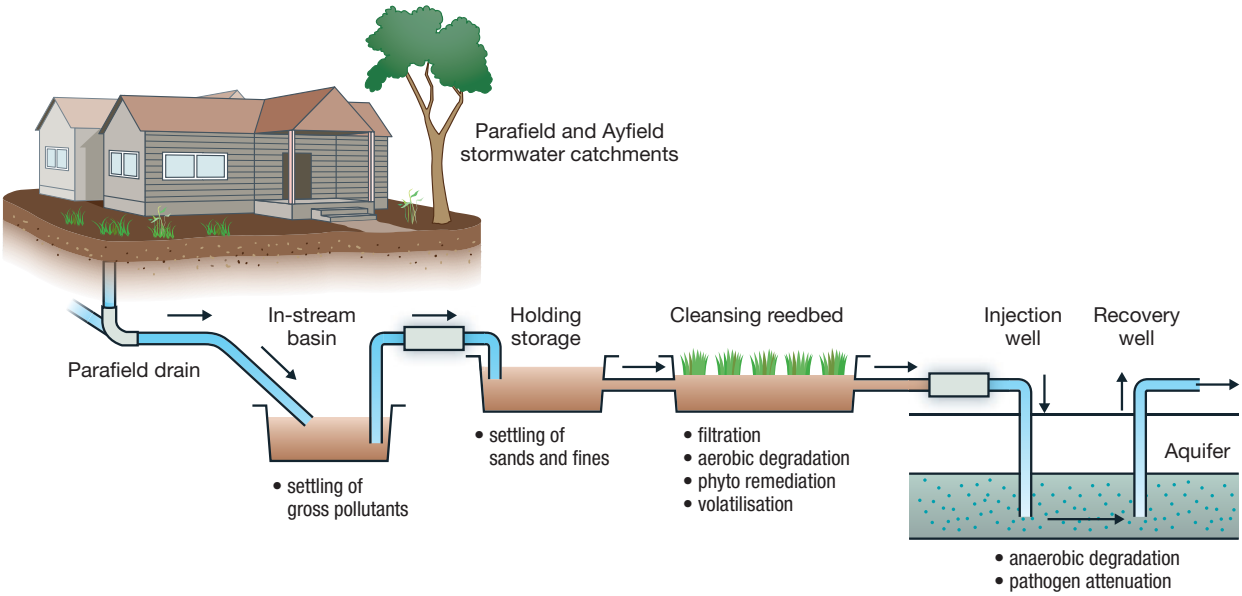
Recycled stormwater

Recycled water involves the catching and cleaning of water that would otherwise run down our streets during times of heavy rain and into rivers before heading out to sea. This water can then be used for non-drinking supplies.

In Salisbury, South Australia, stormwater is captured, settled through a series of ponds to clean the water and pumped underground into an **aquifer**. The water is stored there for drier periods, when it is then pumped up to the surface and is used for watering parks and ovals.

aquifer a geological formation containing groundwater that can supply water to wells or springs

This type of recycling does require large areas for the settling ponds, and not all aquifers are suitable for storage. It does, however, provide a cheap water supply that can be used during dry periods.



Source 4.22 A system in Salisbury, South Australia, for collected and storing stormwater

RESEARCH 4.2

Split the class into groups representing the varying techniques for water recycling, as well as desalination. You are to present at a conference, selling your particular method of water supply to the public. You must explain:

- how your method works
- why it is suitable for your location
- what the advantages are
- any possible problems.

The class will then vote on the best solution at the end of the presentations.

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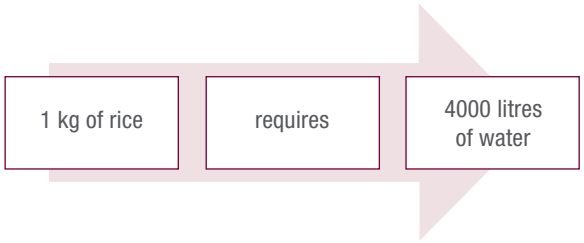
The virtual water trade

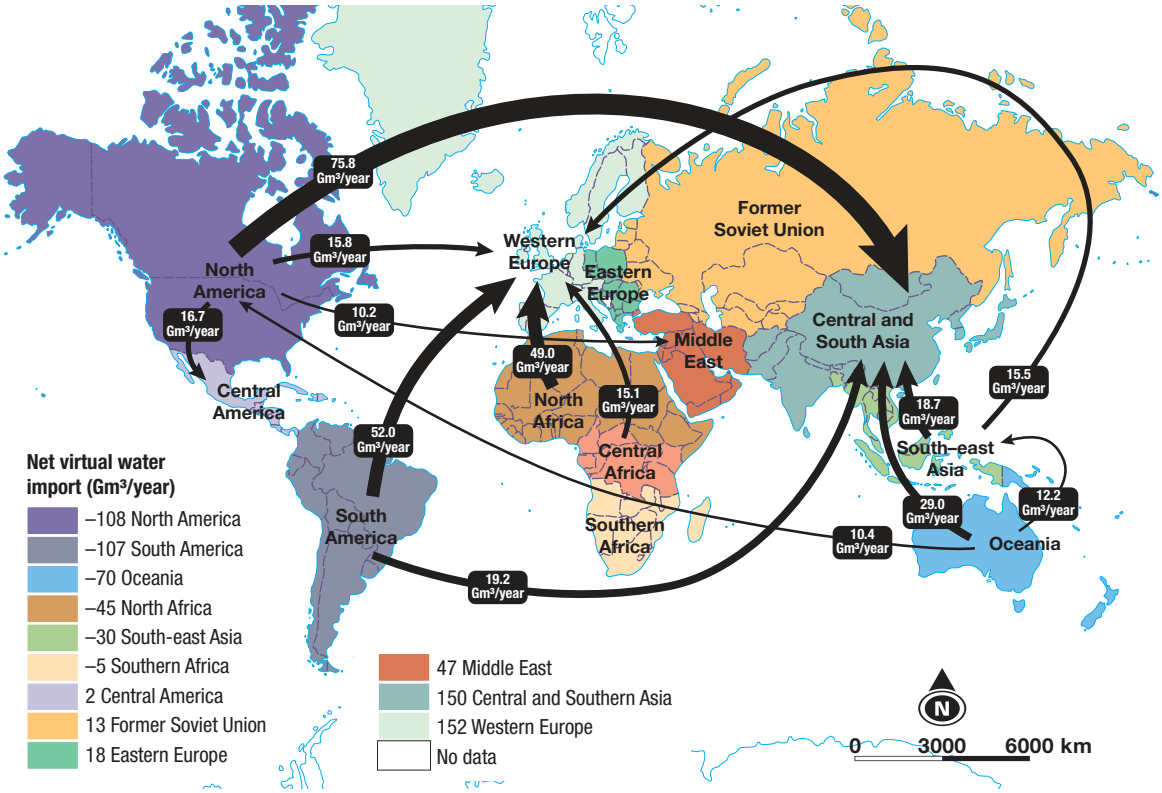
One vital aspect of the movement of water from plentiful areas to those suffering scarcity is very difficult to measure, as it occurs within the goods that are exported between places, for example:



If this rice is exported from India to Egypt, Egypt is effectively gaining 4000 litres worth of produce that Egyptians don't need to find from their water supplies. This is called the virtual water trade.

As Source 4.23 illustrates, much of the virtual water trade involves produce being sent from North and South America, North Africa, South-East Asia and Oceania to Europe, the Middle East and Asia.

Many argue that the virtual food trade is a positive way to 'transfer the water wealth' between those with large amounts of water and those with none, benefitting the source country economically. It has also been said that the virtual water trade has reduced tensions in many areas that are potentially facing conflict over water, while also preventing famines from droughts.



Source 4.23 Net importers and exporters of water

Others suggest that this exportation of water can actually lead to increased water pressure in exporting countries, and that tensions between nations may increase as water supplies in both exporting and importing countries dry up. When droughts occur, food prices can soar, putting economic pressure on those reliant on importing water.

Virtual water and Australia

Australia, despite being the driest continent on Earth, is also the world's largest net virtual exporter of water. Grain, cotton, sugar and beef exports are the major exports that contribute to this.

While these exports may benefit the country economically, they are, in part, responsible for the status of water scarcity in the Murray–Darling Basin, where most of the produce is grown.

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Restricting the use of water

One of the most effective ways of reducing situations of water scarcity is to restrict the ways in which it can be used. This can be done in a number of ways.

Water licences

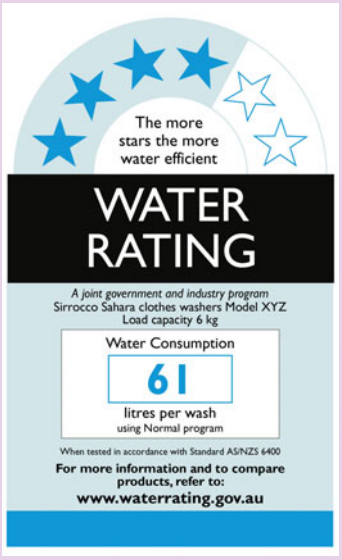
Water licences are most commonly used to allow farmers to take a certain amount of water from rivers to irrigate. These are decided by factors such as previous use or farm size. They are meant to ensure water is shared equally. They don't, however, encourage people to save water.

Taxes

In many nations taxes are being introduced to make those who use large amounts of water pay higher prices. In Israel, households that use over the average amount will be taxed on the excess water use. Other regions are offering tax rebates for those with water-efficient appliances. Some argue that these taxes will affect poorer residents who can't afford the additional costs.

Regulated appliances

Many countries, including Australia, have strict building regulations that insist on certain appliances being fitted to new buildings. These may include water-efficient showerheads, installation of rainwater tanks and dual-flush toilets. This is highly effective, but can add to the cost of new houses and is more difficult to apply to older homes.



Source 4.24 Water Efficiency Labelling and Standards (WELS) rating on appliances

Regulated times of use

In efforts to reduce use, some areas have introduced a system that permits people with odd house numbers to water outside on one day and those with even numbers on the next. Other areas have banned watering in the hottest hours of the day to reduce loss by evaporation. These practices can reduce domestic use, but are difficult to enforce.

Regulated practices

In times of drought, councils or governments may ban the filling of swimming pools, the use of hosepipes and sprinklers or the washing of cars. Those not following the rules may be fined or have their water supply taken away. These measures are a short-term fix, but do affect the quality of life of residents.

High-value to low-value uses of water

As our water supply in agricultural Australia continues to come under pressure, one suggestion is to focus on growing crops that use less water and provide higher levels of income. These are known as high-value uses of water. Lower-value uses of water consume more water and provide less income.

High-value	Low-value
Vegetables	Pasture
Fruit	Rice
Grapes	Sugar
	Cotton

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While this may seem a simple solution, there are some potential problems with it. As a meat-eating nation, we need pasture to provide livestock for slaughter, as well as for dairy products. Australia already has an oversupply of certain high-value crops such as grapes, so planting more of these crops will actually reduce their value.

Many argue that crops such as cotton and rice are not suitable to be grown in Australia and that there should be an emphasis on growing crops that are better suited to the conditions and require less irrigation. This type of shift will, however, threaten the economies of many rural areas and force farmers off the land. It may also require us to be reliant on crops from other countries.

ACTIVITY 4.3

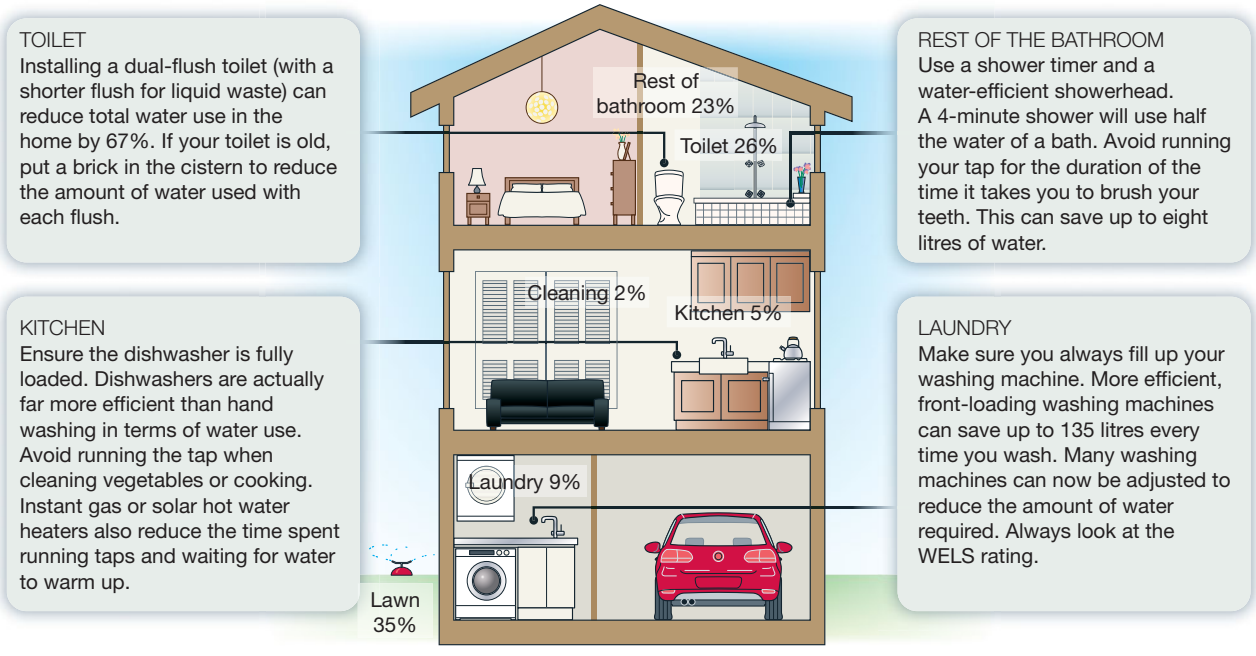
1 Explain 'virtual water trade'.
2 Suggest what is surprising about Australia's status as a virtual water trader.
3 Identify 2 positive impacts and 2 negative impacts of farmers changing from high-value to low-value crops.

Being water-wise

Australia is among the world's highest users of water in the home. This is partly due to our climate; the average Australian uses about 450 litres of freshwater a day, second only to the USA. Ugandans use about a tenth of that amount. There are lots of steps we can take to improve the efficiency of our use of water.

Water-wise in the home

Small changes in behaviour or technological improvements can lead to significant improvements in water efficiency in your house. Encourage your family to adopt some of the practices highlighted in Source 4.25.



Source 4.25 Where we use most of our water in the home and ways we can reduce our water use

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Water-wise in the garden

Around 35% of all water use occurs in the garden, making it an easy area to make savings in our water consumption.

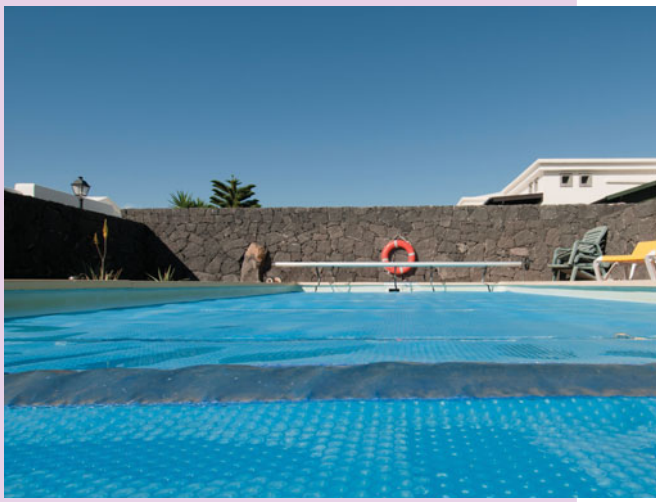
Watering

Ensure dripper systems or microjets are installed to water all plants and vegetables requiring additional water. These reduce the amount of water required and minimise evaporation. A thick layer of mulch can stop up to 75% of evaporation from the soil.

Source 4.26 Drip irrigation is the most efficient away to water your garden.

Swimming pools

Swimming pools can lose up to 10 000 litres of water per month through evaporation. A well-fitting pool cover can almost completely eliminate this loss, while also warming the water in the pool.



Source 4.27 Covers such as this one reduce evaporation.

Native plants

Native plants can also reduce the amount of water required in a garden, as they have evolved to cope with the conditions in their natural environments. Also, talk to your garden shop about other drought-resistant species of plants.

Lawns

Certain species of lawn, such as couch and kikuyu, require far less water than other water-hungry varieties. Make sure you do not overwater your lawn or mow it too often, as this also increases the amount of water required.

Rainwater tanks

Household rainwater tanks can save up to 40 000 litres of water a year. Hooking up these tanks to drip irrigation systems is an extremely efficient way to save water in the garden.

As well as these methods, using grey water as described earlier in the chapter can also save both money and water. If you don't have a system fitted, just take a bucket with you into the shower, collect the excess water and use this to water plants.

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Water-wise at school

As students there are a number of possible ways in which you can improve water efficiency at school. The following activities could lead to some big water savings at your school.

Reducing water use at school

Publicity

Make posters to encourage students to turn off taps and to promote responsible water use.

Avoid leaving water running.

Audits

Are there leaking taps or fountains?

Are dual-flush toilets and water-saving showerheads installed?

Gardens

Are the species of plants around the school grounds appropriate for the climate?

Has the school installed water-efficient measures such as rainwater tanks and drippers?

Being proactive

Form a water-saving club to regularly check for and report leaks.

Ask teachers if there are any grants available to install water tanks or other devices.

Inform other students about the need to save water at assemblies.

RESEARCH 4.3

Conduct an inquiry examining the following question: 'Are we doing enough to save water?'

Complete a water audit of your home and school, finding out about water use, and the extent to which water-saving devices such as water-efficient appliances, dual-flush toilets, water-efficient showerheads, rainwater tanks and drip irrigation systems are being used. You will find a useful link at www.cambridge.edu.au/geography7weblinks.

Create a survey asking parents, siblings, students and teachers about their water use and awareness of water-saving measures. These data could then be graphed and analysed. Present your findings to the class as an oral report and make sure you discuss some steps to improve water efficiency.

Sensitive urban design

While all the approaches outlined in this chapter can go a long way towards saving water, urban planners and architects are now examining different ways to ensure that new urban developments use less water. With careful planning, community and council involvement, and increased education and awareness, millions of litres can be saved.

Modern housing regulations

In many countries, including Australia, governments have put in place strict laws to ensure that water-saving measures are included in the construction of new buildings. All new homes in Australia must have a 2000-litre water tank, for example. A range of other initiatives, including dual-flush toilets, lower water pressure, low-flow showerheads and efficient appliances are also in place in other states and countries. While these approaches do result in water savings, many argue that they raise the cost of new houses.

ISBN 978-1-107-69012-7

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Case study 4.3
Mawson Lakes

Mawson Lakes is a new housing development in Adelaide, and home to around 10 000 people as well as to a range of businesses. The development has been designed with water efficiency at the heart of its buildings. Every building has 2 pipe systems – 1 for normal mains water and 1 for recycled grey water. The grey water comes from a mixture of treated wastewater and recycled stormwater. Grey water taps are painted purple to ensure residents are clear about which supply they are using.

Residents receive separate bills for the 2 systems, with the grey water charged at a much lower rate. The grey water is used for flushing toilets, watering gardens and washing cars. This has reduced use of mains water by over 50%. All the stormwater collected from roofs ends up in wetlands, spread throughout the development. This is pumped underground and retrieved during dry months to water gardens and lakes. Incentives are also given for those in the process of building to use water-efficient appliances.

1. List 1 advantage and 1 disadvantage for strict building regulations to save water.
2. Describe the types of water use that grey water is suitable for and the types of use Mawson Lakes residents are required to use mains water for.
3. Aside from saving water, think of 2 other advantages of having wetlands in a local area.

Source 4.28 Purple taps at Mawson Lakes deliver grey water.

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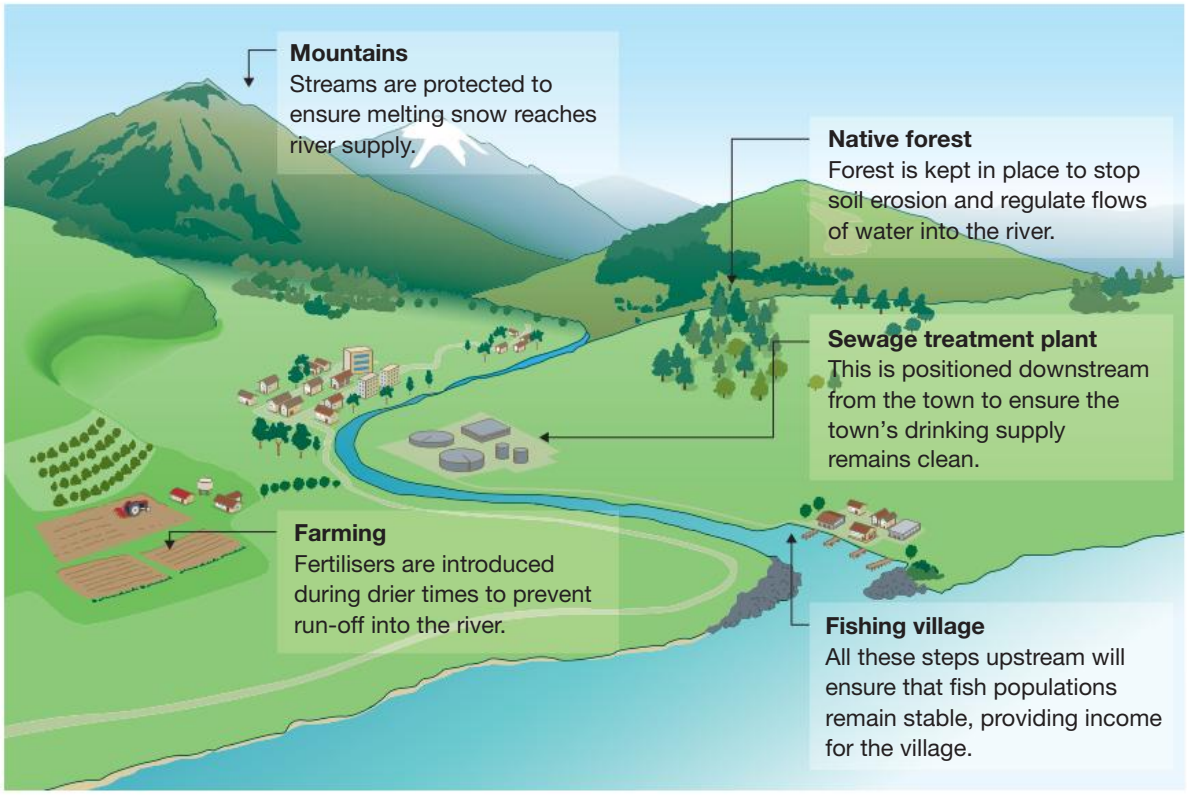
Integrated catchment management

When rivers are managed by people, problems often occur through short-term benefits or local gains being given priority over the overall sustainability of the river system. Examples of poor river management include:

- withdrawal of excess water upstream
- release of contaminants or pollution into the river
- removal of native vegetation.

An integrated approach to managing a catchment means that the river catchment is looked at as a whole when making decisions about the way the land is used. This ensures that the river maintains its health while also allowing for economic development.

Integrated catchment management can be hard to achieve, as many rivers flow through different council, state or national boundaries. Increased awareness and education can assist people in understanding how their actions may put at risk the health of the entire catchment area.



Source 4.29 Integrated catchment management

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Healthy river catchments

Rivers are a vital source of water for human consumption, agriculture and the natural environment. Integrated catchment management advocates that a healthy and balanced river system can support all of these groups. Unfortunately, river systems are under threat. Key threats to systems include the following.

Overuse of water for agriculture

If too much water is taken out of rivers, they suffer from a lack of environmental flow. This means there is not enough water running to the mouth of the river to keep the system healthy. Ecosytems will die and salinity and algae levels may rise.

Water diversion

Rivers have often been diverted to supply water or reduce flooding in urban areas, and dams have been built to secure water supplies. Both these activities can affect flows of sediment, slow the movement of water and prevent the migration of species, lowering water quality.

Pest species

Pest or introduced species such as willow trees or carp in the Murray River can destroy the balance of ecosystems. This can result in the death of certain species, and water quality can diminish.

Source 4.30 The introduction of exotic species such as this carp has led to the extinction of native species.

Pollution from agriculture

Soil erosion from river banks compacted by overgrazing can increase sediment entering the river, decreasing the water quality. Excess fertiliser entering river systems is a major cause of algal blooms. Pesticides can also be washed into river systems, entering the food chain.

Source 4.31 Algae caused by excess fertiliser use in Peru

Pollution from urban areas and industry

Urban areas can create high levels of pollution if industrial waste or chemicals are dumped in the river. Polluted stormwater from roads and drains also enters rivers, killing aquatic life. Warm water, for example from power station cooling towers, can also damage fragile ecosystems.

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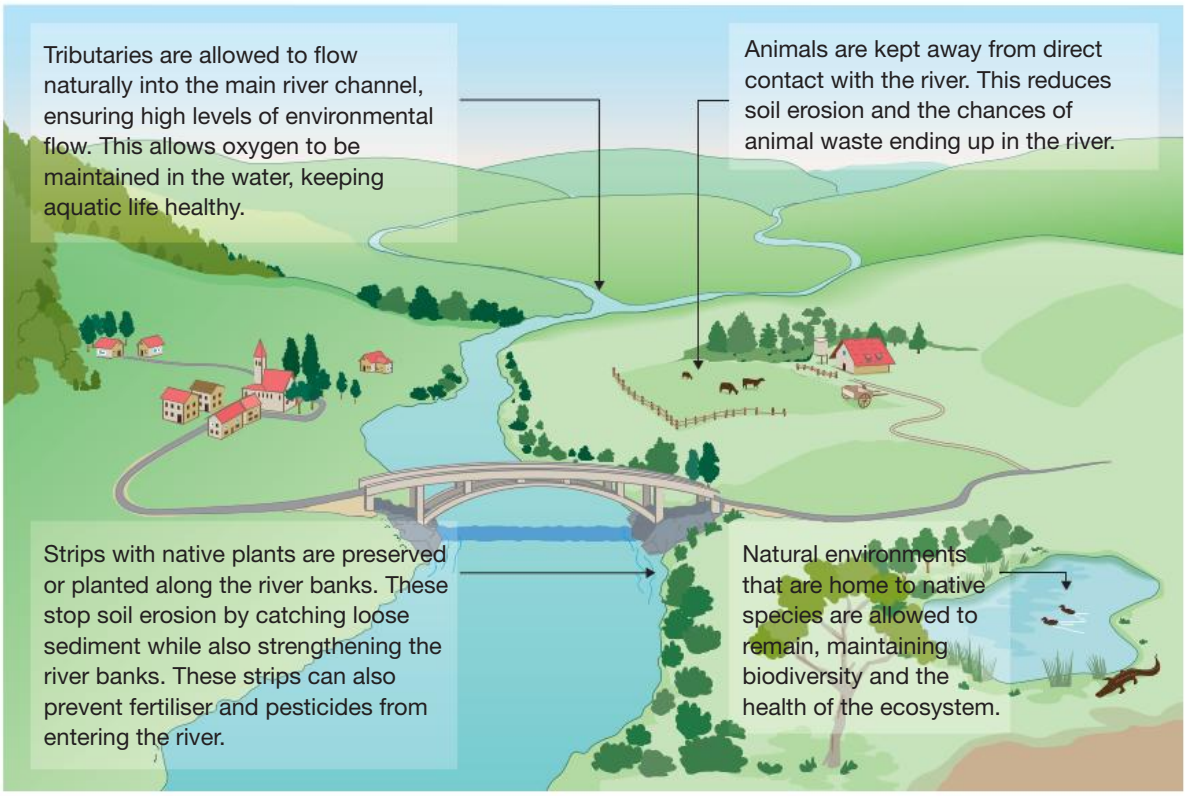
Protecting our rivers: agricultural areas

With so many agricultural regions in Australia reliant on river systems, a variety of strategies can be put in place to maintain healthy water quality (see Source 4.32).



Source 4.32 Maintaining healthy water quality

Populated areas

Densely populated urban areas can cause severe damage to river systems, but there is a wide range of strategies that can reduce the effects of people on the river system.

Wastewater treatment

In many populated areas, sewage and other wastewater can end up in the waterways, increasing the risk of water pollution. Effective treatment and management of that water ensure that these waste products are safe to enter the river.

Litter traps

Litter traps catch litter and other large debris before they enter the river system, reducing contaminants and pollution that may harm wildlife in the river.

Planting of native vegetation in urban areas

Areas of native vegetation such as wetlands can improve the quality of water by filtering it as it flows through the river. These wetlands also bring native species into the area, maintaining biodiversity, which keeps the river system in balance.

Geographical fact

Did you know that water quality in the Thames River in London has improved so dramatically that dolphins have been spotted recently in the middle of London?

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Source 4.33 Natural wetlands in Barnes, West London

ACTIVITY 4.4

1 Articulate what is meant by 'integrated catchment management'.

2 Examine Source 4.29 and refer to page 138. What would happen to the water if:

   a forests were ripped up near the mountains?

   b intensive farming took place upstream from the residential areas?

3 Copy the columns down below and link the causes to the appropriate effects.

Cause	Effect
Introduction of pesticides	Algal blooms
Release of fertilisers into the water	Fragile ecosystems destroyed
Release of hot water from power stations	Poisons entering the food chain

4 Evaluate 2 benefits of planting native vegetation.

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4.4 Challenges for the twenty-first century

Our relationship with water, the amounts we use and the ways in which we use it, vary considerably from place to place. Water scarcity is going to increase this century in many different regions due to a range of factors.

With the population of the world estimated to reach 10 billion by the year 2050, water, both for domestic use and for the production of food, is going to be in extremely short supply. Much of this growth is predicted to occur in Africa, where many regions are already suffering from an acute lack of water.

Source 4.34 Population growth

As average temperatures rise, rivers will experience higher rates of evaporation and more water will be required to irrigate crops. Extreme events such as droughts and floods will increase, leading to uneven distribution of water and periods of greater water scarcity.

Source 4.35 One result of climate change

As countries with large populations, such as China and India, develop, they are likely to require more water as meat consumption rises and more houses receive running water. While parts of these countries have large supplies of rainfall, water scarcity is likely to be an issue in drier regions.

Source 4.36 Improved living standards

Many strategies, such as water recycling or desalination, may provide some of the solutions, but it is clear that current practices will have to be improved if there is going to be enough water for all of the world's population.

ISBN 978-1-107-69012-7

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FIELDWORK 4.1 TESTING WATER QUALITY IN THE TORRENS RIVER

Aim

To examine differences in water quality in the Torrens River, Adelaide, at 3 sections of the river.

Method

Three sites will be tested: 1 at the source of the river near Mt Pleasant in the Adelaide Hills, 1 in the centre of Adelaide north of the CBD and 1 close to the mouth of the river, where natural wetlands have been created.

Preparations

Borrow a water testing kit from KESAB or another environmental organisation. Make sure you have a camera, note pad and pen with you. The water-testing kit will include pH strips and a turbidity meter. You will also need a tape measure and something that floats to record the rate of flow per metre at each site.

To use a turbidity meter, first put a sample of water into the tube. Record the point at which you cannot see the mark on the bottom of the meter. If you do not have a turbidity meter, tie a heavy item, such as a stone, to a piece of string and lower it into the river, recording how deep the water is when it you can't see it any more. Clear water provides evidence of a lack of sediment and algae, and of good environmental flows.

To measure pH, take a sample of water and dip the pH strip into the water. Measure this against the chart provided. If the water is very acidic or very alkaline, this may indicate pollution in the area.

To measure water flow, lay your tape measure out for 1 m, throw in your float, and record how long it takes to travel 1 m. Water flow varies depending on where you are in the river, but it can indicate environmental flow or a lack of regulation.

Data collection

As you travel along the suggested path on this fieldwork trip, stop at the 3 sites and collect the following information in preparation for your fieldwork report.

1. Predict where you think the water quality is going to be the best.
2. Take photographs or sketch the area to record land uses, types of vegetation and any alterations to the river. Has the water been regulated? Does vegetation look native or introduced? What bird or aquatic life can you see?
3. Use the testing kit to record the pH of the water, how fast it is flowing and the turbidity (how clear the water is). Neutral pH, clear water and a fast rate of flow are usually indicators of good water quality.
4. Back at school, create graphs comparing flow rate, pH levels and turbidity and use them to draw up a profile of each site.
5. Now annotate the photographs of each site and recall the levels of wildlife, and try to connect these to your test results.
6. Conclude by relating your findings back to your predictions.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map – Torrens River map
Page 3	Introduction – brief description of the study sites
Pages 4 and 5	Analysis of water tests and photographs
Page 6	Conclusions
Page 7	Appendix, bibliography, glossary

ISBN 978-1-107-69012-7

Chapter summary

- While there is plenty of water available in the world, it is not always in the places where it is needed at the right time for human use.
- Physical and economic water scarcities are pressing and important issues in both developed and developing nations.
- Water is a source of conflict between and within many nations. As populations increase this is likely to be an even more significant issue.
- There is a range of approaches to tackling water scarcity. All of these approaches have advantages and disadvantages, and different approaches will be required in different locations.
- Water can be saved at home, at school or at work. Individuals can make a big difference by making small changes to their water-use habits.
- Integrated catchment management and careful protection of rural and urban river catchments can significantly improve the quality of water in a region.

End-of-chapter questions

Multiple choice

1 Economic water scarcity occurs when:

- **A** there is not enough water to go round
- **B** a region suffers a drought for more than 6 months
- **C** there is water, but there is not enough money to access it safely
- **D** water prices exceed $1 a litre

2 Which of these countries is not in the Nile Basin?

- **A** Egypt
- **B** Nigeria
- **C** Sudan
- **D** Ethiopia

3 Which 2 of the following statements are true regarding treated effluent?

- **A** It is dangerous to drink.
- **B** The public don't always like the idea of drinking it.
- **C** 30% of Singapore's drinking water comes from treated effluent.
- **D** People in many states in Australia drink treated effluent.

4 Which 1 of these problems is associated with the release of fertilisers into rivers?

- **A** Chemicals entering the food chain
- **B** High salinity
- **C** A lack of environmental flow
- **D** Algal blooms

5 A technique in which all the uses of a river catchment are considered to ensure that it stays healthy is known as:

- **A** riparian strip management
- **B** integrated catchment management
- **C** locational drainage management
- **D** Healthy Rivers 2012

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Short answer

1 Explain the difference between physical and economic water scarcity.

2 Describe 3 factors that make conflicts over water more likely to occur.

3 List 3 situations in which desalination is a preferred alternative water supply.

4 Record a paragraph describing what strategies your family could use to save water. Come up with 2 further ways in which more savings could be achieved.

5 Investigate in detail 1 of the challenges for the twenty-first century regarding water. Provide statistics and images to explain why this could be a problem.

Source 4.37 A water tanker supplies water to homes in Bangalore, India, after acute water shortages in the region.

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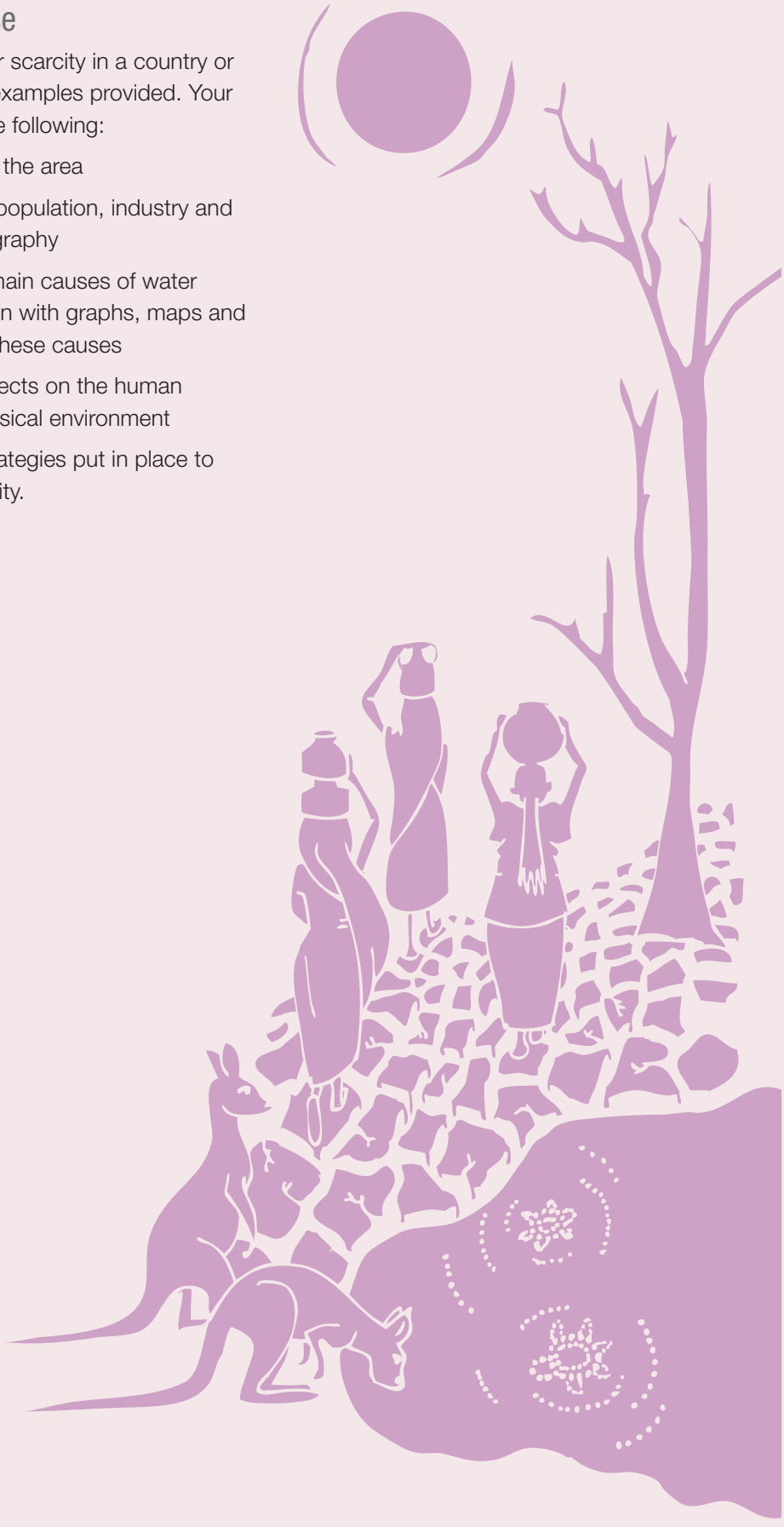
Extended response

Write a report on water scarcity in a country or region other than the examples provided. Your report must include the following:

- a locational map of the area
- information on the population, industry and environmental geography
- an analysis of the main causes of water scarcity in the region with graphs, maps and images explaining these causes
- an outline of the effects on the human population and physical environment
- an evaluation of strategies put in place to reduce water scarcity.



ISBN 978-1-107-69012-7

5 Water hazards

Source 5.1 Water-depth marker in the dry lake bed of Lake Albert in South Australia following years of below-average rainfall across the Murray–Darling Basin

ISBN 978-1-107-69012-7

Before you start

Main focus

Water is not only one of the basic ingredients for all life on Earth and an important part of environmental systems that keep the planet healthy; it is also a central element in some of Earth's greatest hazards, such as floods and drought.

Why it's relevant to us

Unlike with other natural hazards such as earthquakes or bushfires, there are few places on Earth that are not susceptible to hazards associated with too much or too little water. In a world where the climate is changing and more and more people are settling in areas that are subject to water hazards, understanding how these hazards arise and how to effectively manage them is essential.

Inquiry questions

- What are water-associated hazards and how do they occur?
- How do water-associated hazards affect both human communities and the environment?
- How are water-associated hazards managed?
- Are water-associated hazards going to be much worse in the future?

Key terms

- Climate change
- Drought
- Floods
- Hydrological hazards
- Meteorological
- Severe storms
- Tropical cyclones
- Tsunami
- Water cycle

Let's begin

Australia is the flattest and driest continent on Earth – a land of 'drought and flooding rain' as the words of Dorothea Mackellar's famous poem, 'My country', describe it. Australians, like many other communities around the world, have learned to live with water-associated hazards. Australians are fortunate, however, in that the relative number of lives lost to these types of hazards is low and the ability to recover economically after disaster strikes is far greater compared to poorer communities around the world, where hazards associated with too much and too little water bring devastation, death and disease on a huge scale.

ISBN 978-1-107-69012-7

5.1 Floods

hazard a situation that poses a threat to life, health, property or the environment

hydrological hazard a hazard associated with water that has the potential to cause death, loss of possessions and loss of crops leading to famine

developing countries poorer countries of the world that are seeking to become more advanced economically and socially

flood plain low-lying land along river valleys, lakes and coastlines that is subject to flooding

tropical cyclones storms that form over the ocean as a result of warm waves, clouds and low air pressure

Unlike other natural **hazards**, such as earthquakes, which are a significant threat only in certain regions, flooding is one of the major **hydrological hazards** that disrupt the safety, health and prosperity of human settlements all around the world. Flooding is becoming an increasingly pressing problem, as the population of cities, towns and villages swell, particularly in **developing countries**. It is a problem made worse by the fact that many of the world's human settlements are built on **flood plains** or are in low-lying coastal areas that are susceptible either to rising sea levels as a result of a changing climate, or to increased severity of events such as **tropical cyclones**, which push seawater onto the shore.

Globally, **floods** are the most frequently occurring destructive natural events, affecting both rural and urban settlements, and are extremely costly in social, economic and environmental terms. In Australia, since the first recorded death as the result of a flood in 1790, there have been over 2300 flood-related deaths. In the period between 1967 and 1999, the cost of floods in Australia, through the destruction of economic assets such as homes and businesses and the washing away of roads and railway lines, has been estimated at $10.4 billion – the equivalent of $314 million annually. The environmental costs of floods are also rising because agriculture and greater **urbanisation** are contributing to problems like increased soil **erosion**, and during periods of flood the by-products of agricultural processes such as fertilisers and pesticides, as well as industrial pollutants from urban areas, are being washed

flood a large overflow of water that drowns areas of land, usually causing extensive damage to those areas

urbanisation the process whereby more and more people are coming to live in towns and cities

erosion the wearing away of the surface of the Earth by the action of wind and water

Source 5.2 People being evacuated from floodwaters in Nonthaburi, Thailand during widespread floods in October 2011

ISBN 978-1-107-69012-7

Cambridge University Press

ecosystem a community of living things, including animals, plants and microorganisms

severe storms storms, including thunderstorms and cyclones, that cause serious damage to the country

storm surge ocean water that is pushed onto land by the effects of a severe storm or cyclone

tsunami an ocean wave, sometimes large, caused by an undersea earthquake, volcano, landslide or other disturbance

into our oceans, causing long-term environmental damage to marine **ecosystems**. It is the combination of these factors that make floods the most costly of natural hazards in Australia.

The term 'flood' in its most basic sense refers to a flow of water over areas that are habitually dry. Floods include a range of events, many of which can include other sources of damage, such as wind damage associated with **severe storms**, or landslides when waterlogged soil becomes unstable. Sources of floodwater can come from the sea (in the form of **storm surge** or **tsunami**), from the melting of glaciers or winter snow, or from rainfall if the volume of water exceeds the capacity of rivers and creeks or other drainage systems to deal with it.

Flooding can also occur through the failure of human-made water containment systems, such as dams, or through other types of human interference with the natural flows of rivers, such as building bridges over rivers. However, while flooding can become a cause for serious concern when it exceeds the coping capacities of affected communities, it must be remembered that it is a natural process that can also bring great benefits to both human and natural environments. Natural systems have evolved to deal with excess water and floods can have significant benefits, particularly in areas that have suffered a long **drought**.

drought a shortage of rainfall over an extended period of time

The Barmah–Millewa Forest, which straddles the Victorian and New South Wales border north-east of the Victorian town of Echuca, is one example of an ecosystem that needs regular flooding of the Murray River to ensure a healthy environment for its river red gums and for essential bird-breeding habitats.

It is when excess water interacts with natural and human-made environments in a negative sense, causing disruption, damage and death, that flooding becomes a hazard. The experience of flooding for a farmer in Australia's Murray–Darling Basin and that of an urban slum dweller in the Philippines will be very different: to the farmer, the flood is a natural force that brings long-term benefits such as increasing the fertility of the soil, but for the person living in a slum in the city, flooding has the potential to be disastrous, destroying lives and livelihoods.

Source 5.3 Flood marker on the Murray River

Geographical fact

The Chinese Emperor Wu from the second century BCE offered one of the earliest human accounts of flooding.

The River broke through at Huzi – what could we do?

Beneath its rushing waves – villages all became part of the river.

The villages have all become rivers – and there is no safety for the land;

Our labourers know no rest – our Mountains crumble.

Our Mountains have all crumbled – and the Juye Marsh overflows;

Even the fish lament as the winter days press near.

Raged from its boundaries – the River has left its constant course

Like dragons leaping forth – free to wander afar.

Let it return to the original channel – and we will truly bless the gods!

Source 5.4 Emperor Wu on flooding of the Yellow River (Huang He) threatening villages

ACTIVITY 5.1

1. Explain why floods are the most widespread of natural hazards.
2. In your own words, describe what is happening in Emperor Wu's poem and how he feels about the disaster.
3. Investigate why China's Yellow River has been given the name 'River of Sorrow'.
4. In Australia, most local governments have flood maps that show the potential for flooding along creeks and rivers. Analyse how flood maps may help when planning development in these areas.
5. Recall if there has been a flood in the area or state in which you live. Describe the ways in which this event was destructive to both the human and natural environments.
6. Critically evaluate if it is only humans that are affected by flooding. Discuss how floods can affect animals, particularly farm animals.

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Source 5.5 A section of an ancient Nilometer in Aswan, Egypt. The Nilometer was important for the ancient Egyptians in measuring the water height of the Nile to determine whether the coming year was going to be one of feast or of famine.

Human societies have evolved to deal with flooding. For thousands of years, the people of Egypt celebrated the life-giving flooding of the Nile River. From August to September every year, the waters rushed down the river from annual rains in the Ethiopian highlands and **inundated** the fertile lands of the Nile **delta** with water and **silt**, 2 essential ingredients for the growing of crops. But, as the ancient Egyptians discovered, this event was highly unpredictable. The floods brought the fertile volcanic silt from the inland to nourish their lands, but if not enough rain fell, the Egyptians would experience drought and famine. Similarly, if too much water came down the river, the results were equally devastating, washing away homes and livelihoods.

inundate to flood an area

delta a generally triangular area of land at the mouth of a river where the river branches out before entering a sea or lake

silt small particles of soil and rock that are carried along by the force of rushing water and deposited in areas of still water

Flooding is part of the natural cycle, and the Egyptians learned to live with it. The Egyptians even invented some of the first devices to accurately record the flow and height of rivers. The Nilometer was a device built in the banks on the Nile that measured both the clarity of the water (to see how much precious soil was being carried in the floods) and the river height (to see how much water was coming down the river). By setting these up along the length of the Nile, the Egyptians could get an idea of how much water was coming down the river and could take precautions if a higher than usual flood was going to occur.

For the ancient Egyptians, this knowledge of how the Nile River behaved was built up over hundreds of generations and, as we have read, they incorporated this knowledge into their way of living.

For many early European settlers to Australia who were used to the regular flows of European rivers, there was a general lack of knowledge about the irregular behaviour of Australian rivers and

Source 5.6 Flood plain of the Murrumbidgee River below the present town of Gundagai, New South Wales

ISBN 978-1-107-69012-7

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their potential to flood. This lack of understanding was the cause of one of Australia's earliest major disasters. In one deadly night in 1852, the Murrumbidgee River broke its banks after a period of heavy rainfall and wiped out the New South Wales town of Gundagai. Despite the warnings of the local Aboriginal people, whose intimate knowledge of the area went back thousands of years, the early European settlers built their town on the flood plains of the Murrumbidgee River, seeking out its fertile richness in what is the driest inhabited continent on Earth. Their refusal to acknowledge the warnings of the local Indigenous people and to understand the destructive potential of a flooded river caused the deaths of at least 78 people in a town with a population of 250.

ACTIVITY 5.2

1. Construct a time line documenting the history of flooding for a river in your state.
2. Describe a river delta and, using library or internet resources, investigate its characteristics and the way in which deltas are created.
3. Most of the major river systems of the world have deltas at their mouths. The Nile delta is an example of a delta. Identify 1 of the major river systems in the world, such as the Mississippi River in the United States or the Yangtze River in China, and use Google Earth to follow it to its mouth.
   - **a** Describe what happens to the river the closer that it gets to the sea.
   - **b** Investigate whether there is human development in the area surrounding the delta. If so, identify the risk from flooding that these communities face.
   - **c** Consider whether the landscape of the delta you are exploring might change over time. If so, why?

NOTE THIS DOWN

Copy the table below and list the positive and negative effects of flooding on both the human and natural environments.

Human environments		Natural environments	
Positive	Negative	Positive	Negative
Deposits fertile soil on the flood plain for growing crops like rice	Inundates homes	Provides wetlands for breeding birds	Erodes river banks

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How are floods caused?

The most common cause of flooding is from heavy rainfall. It occurs when natural watercourses such as rivers and creeks, or urban watercourses such as drains and culverts, cannot contain excess water within their banks, and the water overflows into the surrounding areas. Floods do not always occur from heavy rainfall, however. In coastal areas, flooding can also occur when seawater inundates low-lying coastal land, because of tropical storms or cyclones, or as a result of higher than normal tides. Coastal flooding can also occur as the result of a tsunami swamping the coast. Flooding can also occur as the result of earthquakes or landslides. A dam failure triggered by an earthquake will result in flooding downstream, even in dry weather, and a landslide that blocks a river's flow can result in flooding upstream as water is backed up, because the river's natural flow has been restricted.

Classification of floods

Floods can be generally classified into 5 types:

1 *Cloudbursts*. When sudden and large amounts of rain fall in a geographically small area and the watercourses cannot contain the increased water flow, flooding occurs in low-lying areas. These are what are termed rapid onset floods, and they can pose a significant risk to life and property. This is because they generate a fast and dangerous flow of water, and there is generally much less time for people to take preventative action.

2 *Natural river floods*. Flooding of the low-lying areas along river margins is a natural event, such as the flooding of the Barmah Forest on the Murray River or the historical flooding of the Nile River. River flooding is generally a seasonal event, either when winter snows melt and combine with spring rains (in temperate regions) or because of the heavy rains of the wet season or monsoon season in tropical and sub-tropical regions. These types of floods are called slow-onset floods. The wet season in the Northern Territory, between December and March, causes widespread flooding that makes many roads impassable. The slow-onset floods may take days to build up and can last for weeks or even months on some occasions. The periodic floods that inundate vast flat areas of arid inland Australia often take weeks to reach places hundreds of kilometres downstream, and can last for prolonged periods. The damage caused by floods in these areas can lead to great losses of livestock, cut off rural towns and spoil crops as well as main roads and railways.

Source 5.7 A farmer in western outback Queensland faced with the heartbreak of destroying stock that became bogged as a result of heavy rains and flooding following many months of drought in February 2003

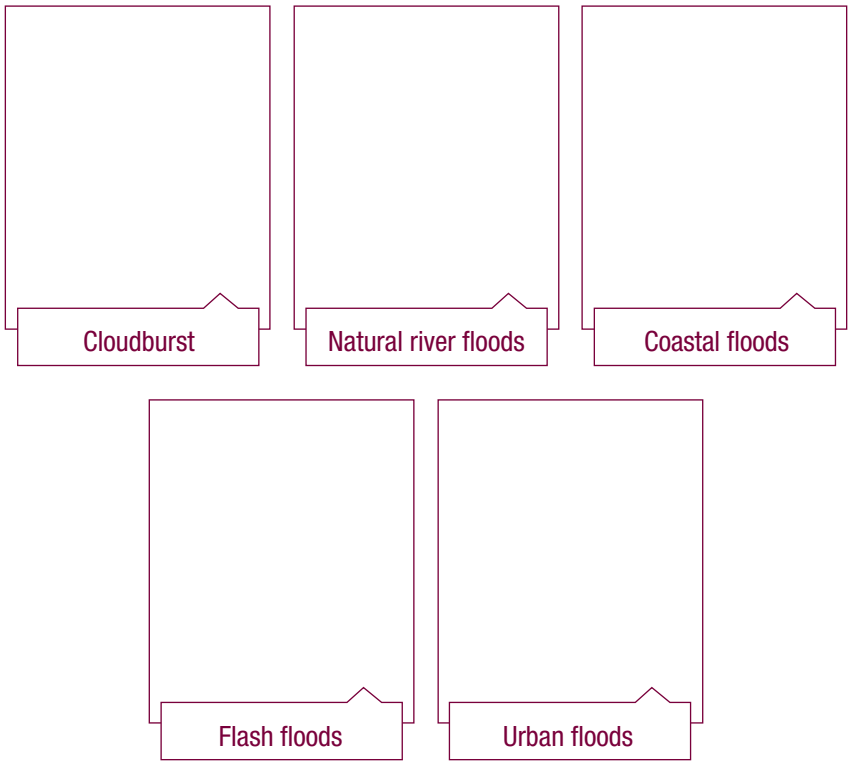
ISBN 978-1-107-69012-7

Cambridge University Press

3 *Coastal floods*. Fierce winds from tropical storms and cyclones can drive seawater onto low-lying coastal land in storm surges. This can be made worse during higher than normal tides or when higher river flows are coming into estuaries. Coastal flooding can also be produced by tsunamis.
4 *Flash floods*. Gullies, canyons or normally dry creek beds that are found in semi-arid areas can quickly become powerful fast-flowing torrents during storms.
5 *Urban floods*. As urban land in cities and towns is developed and paved with bitumen and concrete, it loses its ability to absorb rainfall. In intense rainstorms, rainwater quickly becomes run-off, flooding drains and culverts and overflowing into low-lying urban settlements.

NOTE THIS DOWN

Copy the graphic organiser below and create an annotated visual display of the 5 flood-type classifications listed above. For each of the classifications, either draw a visual image or find one on the internet that is relevant to the description. Each classification should have its own subheading and a brief description.



ISBN 978-1-107-69012-7

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Geographical fact

For thousands of years humans have understood the power of moving water. References to water mills occur in ancient Greek, Roman and Chinese texts. These early water mills turned millstones as the river flowed, grinding grain. The power of water in flood, however, is uncontrollable. It can carry massive boulders and trees in its currents and wash away buildings and bridges. Cars are easily swept away and people have little defence when they attempt to cross flooded creeks. One way to think of this force is to envisage the weight of an average bathtub of water – about 750 kg or about the weight of a cow. So imagine the force of hundreds of thousands of litres of fast-flowing water in a flood; it would be like being hit by a massive herd of fast-moving cattle. Watch the YouTube video of the 2011 Toowoomba flood and see how easily the floodwater swept away cars.

RESEARCH 5.1

Many people drown in floodwater because they try to walk or swim across flooded creeks and rivers or they attempt to drive their cars through floodwater that covers roads. People seriously underestimate the force of flowing water. In this experiment you are going to measure how the volume of water influences its force. Before beginning any experiment, you need to formulate a hypothesis. A hypothesis is a theory about something that can be experimentally tested. First write down your hypothesis about how the volume of water will influence its force. Then, in small groups, complete the following experiment.

MATERIALS

- 1.2 litre plastic soft drink bottle
- Ruler
- Thumbtack
- Large plastic tub
- Towel
- Permanent marker
- Jug of water
- Duct tape

PREPARATION

- Use the ruler to measure a distance of 5 cm up from the bottom of the bottle. At the 5 cm point, use the permanent marker to mark a dot. Draw a line on the bottle horizontally from each side of the dot. Complete these steps at 5 cm intervals until you reach the 20 cm mark.
- Use the thumbtack to pierce a hole at the 5 cm mark only and place a piece of duct tape over the hole.

(*continued*)

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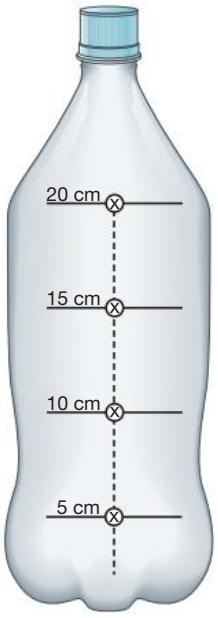
METHOD

1 Fill the bottle to the 20 cm mark with water.
2 Place the bottle at one end of the tub with the hole pointing inwards. Using the ruler, mark increments of 2 cm on the bottom of the tub away from the base of the bottle to the end of the tub.
3 Remove the duct tape from the hole on the bottle and measure the distance the water projects from the hole. Cover the hole with your finger and mark the distance in the table below.
4 Repeat step 3 two more times, ensuring that the water is topped up to the 20 cm mark each time. Record the distance the water projects both times.
5 Repeat steps 3 and 4, but this time fill the bottle only to the 15 cm mark. Enter the results into your table.
6 Repeat steps 3 and 4, but this time fill the bottle only to the 10 cm mark. Enter the results into your table.
7 Repeat steps 3 and 4, but this time fill the bottle only to the 5 cm mark. Enter the results into your table.



Source 5.8

OBSERVATIONS

Volume	Trial 1	Trial 2	Trial 3	Average
20 cm				
15 cm				
10 cm				
5 cm				

CONCLUSION

1 Was your hypothesis about how volume affects the force of water correct? Why or why not? Use the data to support your answer.
2 Apart from people underestimating the force of floodwater, what are some of the other risks associated with driving a car through floodwater?

The water cycle and flooding

As we have read, the most common form of flooding is water overflowing the banks of rivers and streams and this occurs when an excessive amount of rain falls in the area that supplies the water to a stream or river. This area is called the catchment or drainage basin. In nature, a drainage basin is an area that is surrounded by higher land such as hills or mountains. To illustrate a drainage basin, cup your hands together under a shower of water, with your hands pointing slightly upwards. The water from the shower is like rain. The water that falls in your cupped hands is falling into a drainage basin, gets channelled down the valleys between your fingers, runs into the valley between your palms and eventually drains out between your wrists. The valleys between your fingers and palms are like the creeks and rivers. Try experimenting with this model. What happens when you increase the flow of water? What happens when you decrease the flow of water?

ISBN 978-1-107-69012-7

Cambridge University Press

Geographical fact

The definition of a flood does not have to include water. In January 1919 in Boston in the United States, a large molasses storage tank at an alcohol distilling company burst, sending a wave of molasses through the streets at an estimated 56 km/hour. This most unusual of urban floods killed 21 people and injured 150 more.

In order to better understand how floods occur in rivers and streams, we need to consider the area through which they flow as part of a system called the water cycle – an endless, naturally balanced cycle, in which water passes from the oceans into the atmosphere, onto the land, through and under the earth, and then back to the oceans. This water balance and its cycle are achieved by the combination of the sun's heat and the pull of gravity, both of which constantly recycle moisture, which **evaporates** and enters the air as vapour, then **condenses** and falls back to earth as rain, snow, hail or sleet. This falling back to earth is called precipitation and forms the input into the system. When it falls onto the land in the catchment area of a river, a number of things may happen. It may return to the atmosphere through evaporation from the ground surface and through **transpiration** from plants, which together form an output from the system called **evapotranspiration**. When water gathers on the ground, when the soil soaks it up. This is called infiltration. The speed of infiltration is called the infiltration rate. Once in the soil, the water moves quite slowly, either near the surface in what is called through-flow or much deeper as groundwater flow. Any water that does not infiltrate moves rapidly downhill on the ground surface and is called run-off. Too much run-off is the most common cause of rivers and streams overflowing their banks and causing floods.

evaporates changes from liquid to vapour

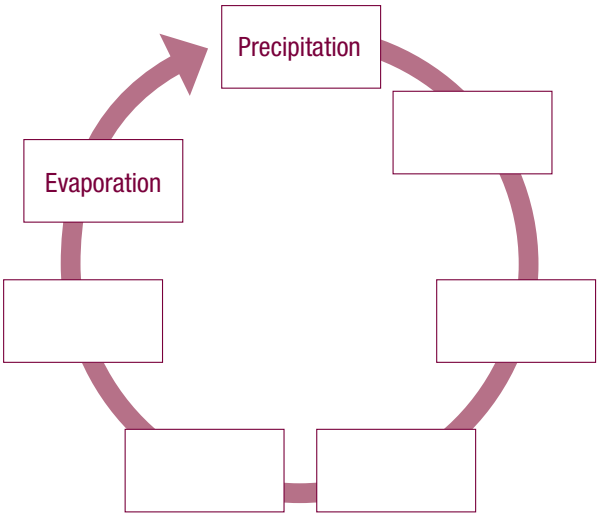
condenses changes from vapour to liquid

transpiration the process by which plants lose water to the atmosphere

evapotranspiration the process whereby water is released into the atmosphere through evaporation and the transpiration of plants

NOTE THIS DOWN

Copy and complete the graphic organiser shown and, using the information on the water cycle, draw an annotated diagram illustrating how water moves through the system. Key words to use in your diagram are evaporation, transpiration, precipitation, infiltration, through-flow, groundwater flow and run-off.



ISBN 978-1-107-69012-7

Cambridge University Press

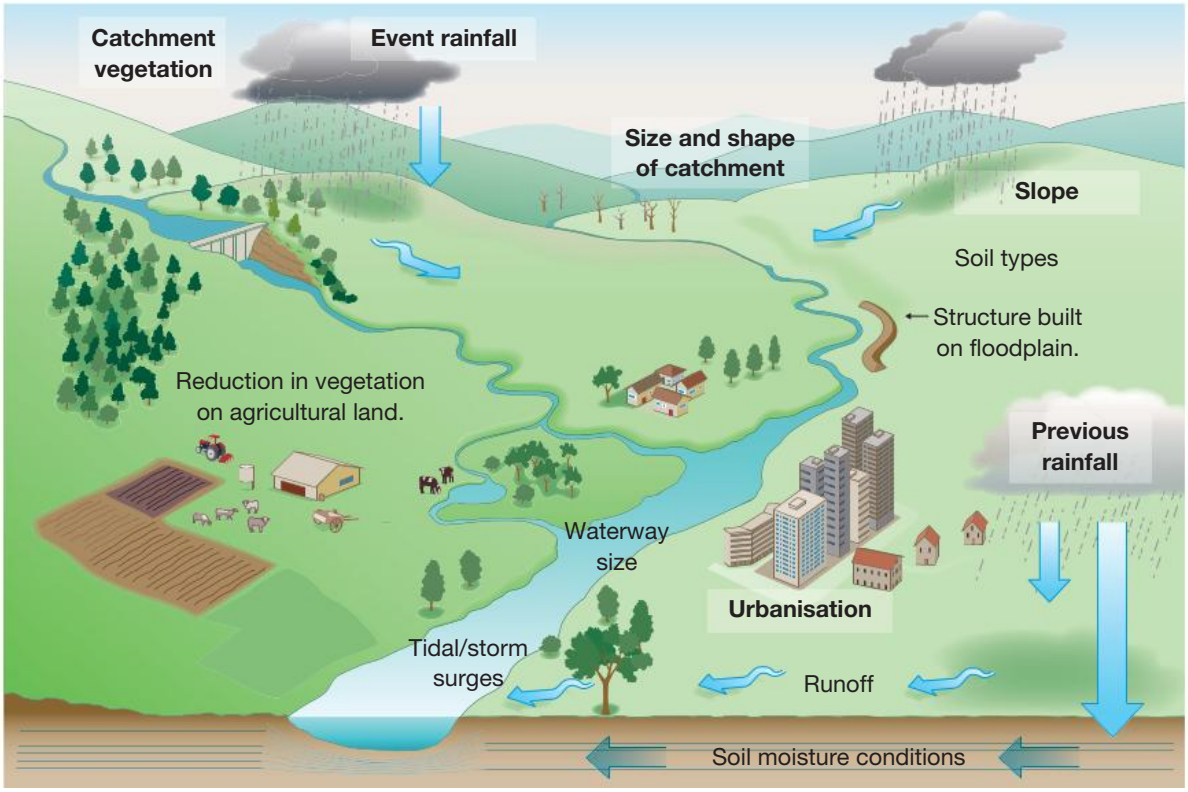
Geographical fact

Scientists have calculated that if all of the water in the atmosphere at any given time were suddenly to fall upon the earth, it would cover the planet to a depth of only a few millimetres. So could the great deluge, for which Noah built his ark as recorded in the Old Testament, have really occurred?

Conditions that lead to flooding

Heavy rain on its own will not necessarily cause destructive flooding. The conditions that lead to flooding are also subject to enormous variability. Flood potential depends on how the rain falls and how the water behaves once it is on the ground. We have all experienced rain that has gently pitter-pattered away over a couple of days. This has generally not caused a problem. However, the same amount of rainfall falling over an hour or 2 could devastate a town. This is what happened to Toowoomba in Queensland in January 2011, when flash flooding swept away everything in its path. The key to understanding the potential for flooding lies in understanding how land behaves, and this depends on a number of factors:

- *Urbanisation and human modifications to the landscape.* Water flows more quickly and efficiently across paved areas than across areas of vegetation, which slow the speed of floodwater and distribute its energy more evenly. So an area with a lot of concrete and bitumen, such as in urban areas, creates run-off very quickly. Modifications to the landscape such as the building of levee banks on flood plains also influence the way that water behaves.



Source 5.9 A typical catchment illustrating some of the factors that influence flooding potential

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- *Soil type.* Soil type influences the infiltration rate. If the ground is coarse and composed of sand or gravel, rain water is absorbed quickly. But if the ground is fine – composed of clay, for instance – less water gets through, and run-off is inevitable. To understand these differences, note that clay has smaller granules than sandy soil, and when it gets wet it becomes very sticky and doesn't allow any more water to be added. That is why clay is very good for making bricks, which are hard and dense and resist water penetrating them. The larger granules of sandy soil easily allow water to pass through.
- *Amount and type of vegetation.* Heavily vegetated areas, particularly those with trees and shrubs, allow for greater water penetration of the soil. The foliage of trees and shrubs also reduces the energy of the falling rain. One of the contributing factors to heavy flooding in Pakistan in the disastrous floods in 2010 was the degree of tree removal by logging in the upper catchment of the Indus River.
- *Recent weather.* Ground that is already saturated from earlier rain events is more likely to create run-off into creeks and rivers because the ground cannot absorb any more water. Rain that puts an end to drought can even cause flooding; it may be falling onto soil that's so sun-baked and hard that it can't absorb much water at first. Soil that is frozen creates conditions for greater run-off because liquid water cannot penetrate the hard soil.
- *Topography.* The shape and the elevation of the land are a strong determinant of floods. Mountains, for instance, are great flood makers. First, they assist in the creation of rain when they cool down warm, moist air blowing into them, and then they channel rainfall into steep channels in virtually no time at all. Flat land such as the flood plains alongside rivers, on the other hand, assists the widespread pooling of floodwater.

ACTIVITY 5.3

1 Interpret what it means to say that 'the velocity of a river is largely determined by gravity'.

2 Identify the benefits for communities building settlements on flood plains.

3 Complete the table below showing the infiltration rates of different soil types and characteristics that influence water run-off.

Condition	Rapid (R)/ slow (S)	Reason for your answer
Frozen soil	R	Frozen soil doesn't allow the water to infiltrate the ground. Therefore run-off will be greatly increased.
Clay soil		
Dry, sandy soil		
Saturated soil		
Bitumen or concrete-covered surfaces		
Densely vegetated area		

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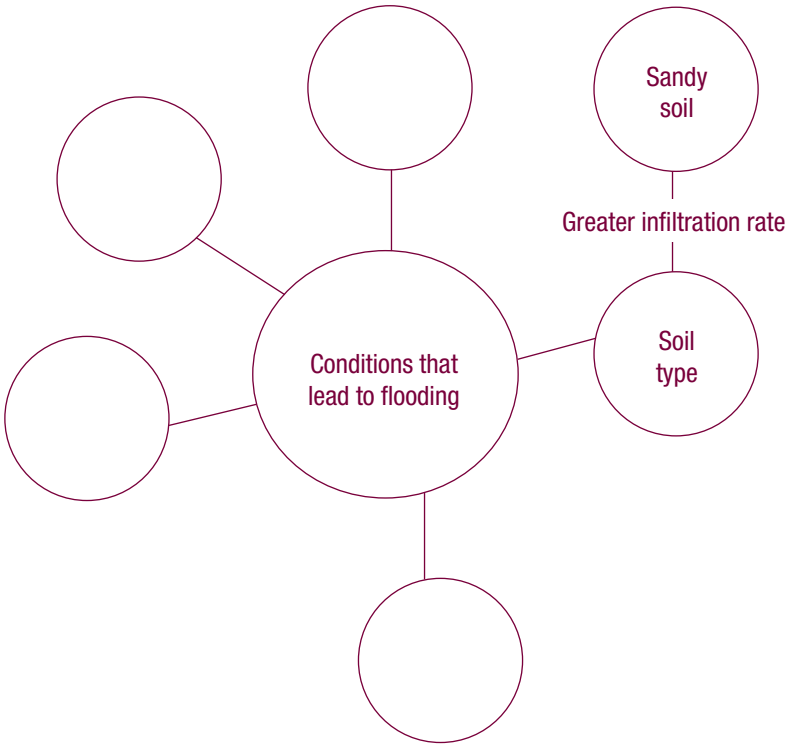
NOTE THIS DOWN

Copy the graphic organiser below and create a concept map outlining the conditions that lead to flooding.



FIELDWORK 5.1 CREATING A GROUND COVER MAP FOR YOUR SCHOOL

Aim

To create a map showing variations in the ground cover and water run-off potential of the different areas within your school.

Method

The whole class can undertake this fieldwork during a couple of periods without leaving the school grounds. With the use of visual observations, a camera and some basic garden tools, data that reveal the type of ground cover that exists within a small geographical area can be collected. The fieldwork is in 2 parts.

Preparation (part A)

On a web mapping application such as Google Maps or Google Earth, locate your school. Draw a rough outline map of your school, using the web map image as a guide. Include the school boundaries and all buildings. This map will be the draft map which you will take with you on fieldwork.

Data collection

1 Survey the different areas of ground cover at your school. Take photographs of the different types of ground cover.

2 Use a colour code to mark the following areas on your map:

- **a** concrete or asphalt
- **b** exposed soil with little or no vegetation
- **c** grassed area or light vegetation
- **d** heavily vegetated areas.

3 Once your fieldwork is complete, you will need to transfer all of your data onto a completed map of preferably A3 size. This map should

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show BOLTSS (except for scale, which is not essential). Your map should have a:

- **B**order
- **O**rientation – indicating north
- **L**egend – showing the features on your map including what each area of shading represents
- **T**itle – a heading that describes the map and what it is showing
- **S**cale – (not essential)
- **S**ource – the details where the information used to create the map came from.

Preparation (part B)

The next part of the fieldwork is to do a soil test to determine the type of soil in the area in which the school is located.

You will need a large jar (about 2 litres) with a lid.

Data collection

1 Fill this jar to about two-thirds full with water.

2 From an area in your school yard where the soil is least disturbed (do not select a prepared garden bed for your site), scrape away the topsoil and dig a hole about 15 cm in diameter. Add the extracted soil to the jar until it is almost full with soil and water.

3 Vigorously shake the jar and let it settle. Settlement may take a couple of days.

4 Once the soil has settled, hold a piece of white card against the jar and mark off the different layers of soil that have settled. The coarsest soil will settle at the bottom and the finer grained soil will settle at the top. Note the percentage of each soil type. If there is a higher percentage of grainier soil, the infiltration potential of the soil will be greater. The more soil with finer grains, the greater the reduced ability of the soil for infiltration.

Once your fieldwork is complete, write a report on the run-off potential of your school during an intense rainfall event and how the land surrounding the school could be better managed to cope with an extreme rainfall event. One suggestion could be that greater areas of the school could be planted with more trees and shrubs. Use an overlay map to show where these changes can take place.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages.
Page 1	Aims, methods and location map – showing the school and where it is located within its geographical region
Page 2	Introduction – brief description of the study site and reason for the investigation. Show photographs of each example of typical ground cover in the survey area.
Page 3	Map of the survey area showing each of the areas of run-off potential, including an overlay map if used
Page 4	Record of the soil test results with photographs showing methods and the survey site
Page 5	Discussion of the conclusions and recommendations for dealing with future rainfall events

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People's experience of floods

The experience for people caught in a flood may vary according to a number of factors:

- *The time of year the flood comes.* People regularly experience floods that are linked to the seasons, such as rain in spring or during the wet season in the tropics. Heavy rainfall that is experienced outside these regular patterns can catch people unexpectedly.
- *The time of day when the worst flooding occurs, how quickly the flood arrives, and how quickly the water rises.* For instance, flooding that occurs at night poses a greater potential threat because people are more disoriented than they would be during the daytime.
- *How long the flood lasts.* In some parts of northern Victoria, floodwater still covered farmland almost 2 years after the January 2011 floods.
- *The depth of the water and the speed at which it flows.* There is little defence from great volumes of rushing water. Many deaths from flooding in places like Australia are the result of people underestimating the depth and speed of water and attempting to drive their cars through a flooded roadway, or walking or swimming across flooded watercourses and being washed away.
- *How well prepared people are for a flood.* People in developing countries such as Pakistan are affected far more severely by the devastation caused by floods than people in Australia. Australia has comprehensive communication systems to warn people of flooding and Australian authorities have stringent planning guidelines for where people can build and what types of houses they can build. In poorer countries, building regulations are less stringent and people, many of them poor, often build in areas that are vulnerable to flooding because of the cheapness of the land. Many people in poorer countries also don't have easy access to telephones, television and the internet, so information that they get about potential floods is often limited.
- *The amount of outside help that is available for rescue and relief operations.* Many countries in the developing world do not have adequate money or resources to deal with flood disasters, and it is because of this difference that people in Bangladesh, for instance, have a far more devastating experience than people in developed countries like Australia.

Source 5.10 A farmer in northern Victoria stands by a huge lake that remains on his farm nearly 2 years after the 2011 floods.

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RESEARCH 5.2

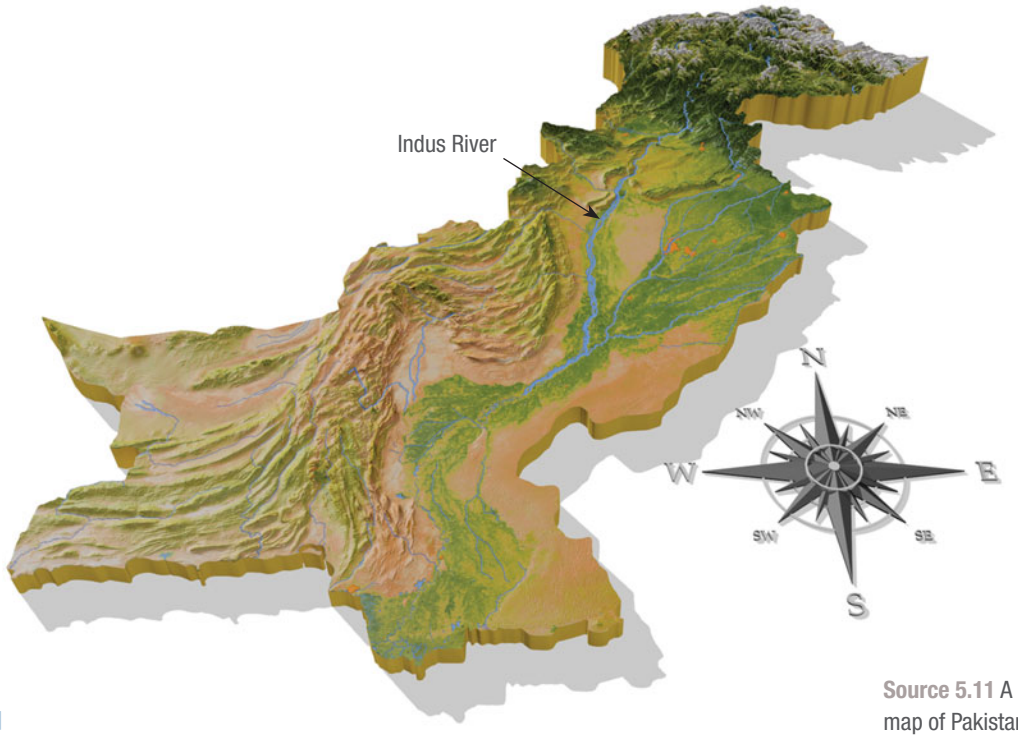
Bangladesh is one of the most fertile areas on Earth, yet it suffers natural disasters on a scale unimaginable to people in Australia. Write a report with an accompanying letter to the Prime Minister of Australia detailing your argument as to why Australia's foreign aid budget for Bangladesh should be increased. Be sure to address the following:

- an investigation of the physical and human geography of Bangladesh
- why Bangladesh is subject to such significant natural disasters and what makes the people of Bangladesh so vulnerable to these disasters
- some suggestions about how these disasters could be better managed
- how increased foreign aid could improve the lives of the people of Bangladesh.

Case study 5.1

A study of 2 floods: Pakistan floods in 2010 and Queensland floods in 2010/11

There are few places on Earth where flooding is not a concern. Anywhere that rain falls is vulnerable, and this is true of 2 very different countries investigated in this case study: Australia and Pakistan. In 2010, within 6 months of each other, both Pakistan and Australia were seriously affected by flooding. In Australia, while there was widespread flooding across the east and south-east of the country such as in Victoria, the impact of flooding was most severely felt in Queensland. For an interactive aerial view of the imapct of the Queensland floods, see www.cambridge.edu.au/geography7weblinks



Source 5.11 A 3-D relief map of Pakistan

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Pakistan floods

Pakistan, in South Asia, is no stranger to severe flooding. Between 1950 and 2010, 18 major flood events have occurred. A major flood event is one that causes significant damage and loss of life. This averages to about one major flood event every 3 years, and these have had an enormous impact on Pakistan's development. In 60 years, more than 10 000 people in Pakistan have lost their lives to flooding, and the country has suffered a financial loss estimated to be about US$30 billion.

Indian monsoon seasonal heavy rains that fall in the Himalayan regions of South Asia

tributary a river or stream flowing into a larger river or lake

Like everywhere else, flooding is part of the natural cycle in Pakistan and the Pakistani people rely heavily on the regular rains of the **Indian monsoon** for agriculture and industry. The major rivers in Pakistan – the Indus and its **tributaries** – are fed by these annual monsoonal rains falling on the mountains in the north of the country.

In July 2010, heavier than average monsoonal rains lasting for over 2 months fell in the upper catchment of the Indus River in Pakistan, causing flooding along its entire length. In certain areas, more than 4 times the normal monthly rainfall fell within 3 days. The 2010 flood was the most destructive flood in Pakistan's recorded history. Floodwater in Pakistan's water catchments combined to create a moving body of water equal in dimension to the landmass of the United Kingdom.

The impacts of the 2010 monsoon were catastrophic: approximately one-fifth of Pakistan's total land area was under water (about 796 095 km^2) and flooding killed over 1800 people and affected 21 million more – a greater number than were affected by the Indian Ocean tsunami, the Haiti earthquake and Pakistan's 2005 earthquake combined. The country suffered more than $10 billion in damages to infrastructure such as irrigation systems, bridges, houses and roads. Vital food crops such as rice, grain, sugar cane and pulses were destroyed, as well as cash crops such as cotton and tobacco. 200 000 head of livestock – cattle, sheep and goats –were killed. People lost not only their lives; a great many lost their homes, their farms and their businesses.

The Indus River, at 3180 km long, flows through Pakistan from north to south. As the topography or shape of the land that the Indus River and its feeder streams flow through changes, so does the behaviour of the river in flood. In the upper regions of the Indus River in the north of Pakistan, where the land is quite steep and mountainous, the watercourses were subject to quick-onset floods such as flash floods, which swept away villages.

Source 5.12 Floodwater surrounds houses in the Punjab region of Pakistan during the 2010 flood emergency.

ISBN 978-1-107-69012-7

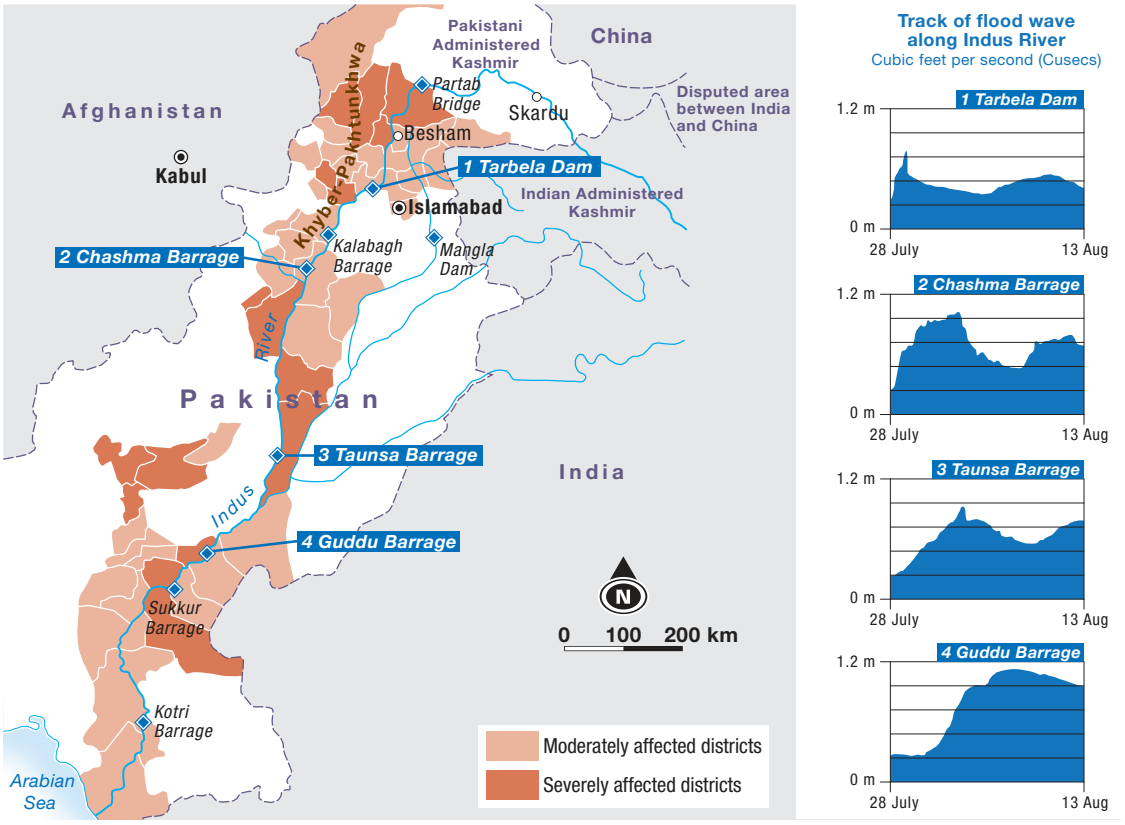
flood peak the highest point that floodwater reaches

Because of the steepness of the land in this region, once the **flood peak** had passed the water quickly returned to the rivers. In the lower regions of the Indus the floodwater behaved differently.

The lower reaches of the Indus, in the south of the country, didn't receive the peak of the floodwater until some weeks after the rains fell in the north. The people in the south therefore had more warning about the oncoming floods, but as the shape of the land was different, the floods had a different impact. The southern regions of Pakistan are much flatter than in the north, and in some places the river flows higher than the land surrounding it because the banks along the river have been built up over thousands of years of flooding, depositing silt. The result of flooding in these regions was that the water could not always return to the river, and if it could do so it was slow to return. So vast areas of land were under water for many months after the floodwater passed through.

The development of towns and villages in Pakistan and the threat they face from flooding is typical of many places around the world, and it is this pattern that highlights the interaction between humans and natural processes. People are attracted to flood plains along rivers where fertile soil has been deposited over tens of thousands of years of flooding. The rich soil encourages farming, which then encourages the growth of settlements, and these will always be under the threat of flooding. Much of Pakistan is arid or semi-arid, and only about 24.4% of land is suitable for farming. Much of this takes place along the fertile flood plains of the Indus River and its tributaries, where the water is heavily relied upon for irrigation, making it one of the longest irrigation systems in the world. The region along the Indus River and its tributaries is heavily populated with **population densities** ranging from between 200 to 1000 people per square kilometre.

population density the number of people that live within a defined area, such as a square kilometre



Source 5.13 The passage of the flood wave along the Indus River during the 2010 floods

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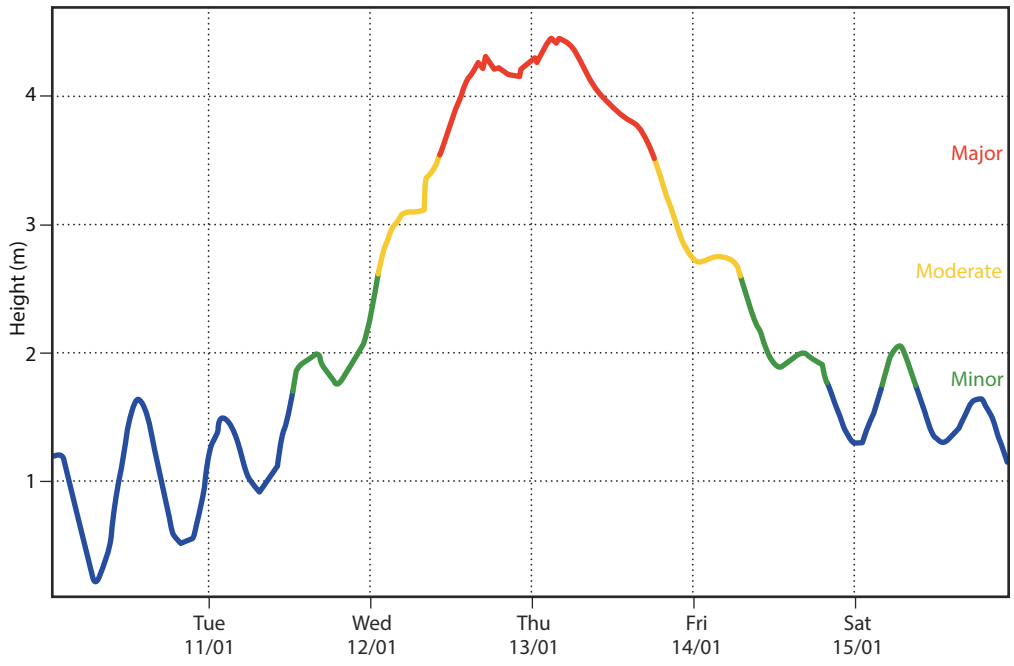
Pakistan is not a wealthy country; the average family income in Pakistan is low, with about 22.6% of the population estimated to be living on less than $1.25 a day. Many of these people are involved in small-scale agriculture, living in villages built on the flood plains, with much of the housing constructed of mud brick, which is quickly washed away in a flood.

After the peak of the floodwater had passed through, the people of Pakistan faced a further crisis. The irony of flooding caused by heavy rainfall is that, despite the huge volumes of water that are involved, fresh drinking water becomes scarce. Many of the wells and storage reservoirs in the flood-affected regions were contaminated by water that carried deadly pollutants, such as raw sewage and the rotting corpses of drowned animals. The threat of waterborne diseases such as **cholera** was enormous. Many homes were destroyed in the floods and roads and bridges were swept away by floodwater or destroyed by landslides. This created a crisis for millions of people who were without proper shelter, fresh drinking water, food and medical supplies. And this crisis was made even worse because many of these people were isolated, not only by the floodwater, but by the fact that roads and bridges were impassable. This put enormous pressure on the Pakistani government and relief agencies to deliver essential supplies. Over the longer term, the ability of the Pakistan people to recover from the floods was affected by the enormous amount of mud and debris carried in the floodwater that swamped farming land, making it difficult to get the ground ready for future crops. The flooding also caused other long-term problems like unemployment in the devastated regions, because of the destruction of business and industry, which affected the ability of communities to recover. This was further compounded by the fact that rebuilding facilities like roads and bridges was hampered by the enormous amounts of money needed.

cholera an infectious disease caused by contaminated water; it causes severe vomiting, cramps and diarrhoea, and can often be fatal

Queensland floods

Coastal Queensland has a warm tropical and sub-tropical climate, and during the summer months from December to February, Queensland



Source 5.14 Flood heights in Brisbane, January, 2011

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experiences its wet season – a time when its creeks and rivers are at their highest levels. It is also the period when Queensland endures its cyclone season. Coping with the wet season is a normal part of life for the people of Queensland, where most of the major cities and towns are located on flood plains within 100 km of the coast and some form of flooding is likely to occur. Queensland's capital city, Brisbane, is deemed highly flood-prone because of its location in a very low-lying part of the Brisbane River Basin, one of the largest coastal river catchments in eastern Australia. Before 2011, Brisbane had already experienced 2 major floods in its history – 1 in 1893 and another in 1974 – and numerous small to moderate floods.

The summer of 2010/2011, however, turned out to be quite different for the people of Queensland. These were some of the wettest months in the state's history, and the result was widespread flooding that affected more than 78% of the state – an area larger than France and Germany combined. Thirty-three people were confirmed dead from drowning in floodwater, and the bodies of 3 people were never found. Most of the state was declared a disaster zone by the government: 2.5 million people were affected in some way by flooding; 29 000 homes and businesses received some degree of flood damage; agricultural and mining production was severely disrupted; and crops of wheat, cotton, sugar cane, citrus, fruit, vegetables and grains were destroyed. The flood also damaged infrastructure, such as rail and road networks, as well as vehicles and machinery. The cost of the floods was estimated to be in excess of $2.37 billion dollars.

While flood-related fatalities occurred throughout the state, most of them in rural Queensland, the highest concentration of deaths occurred in the Lockyer Valley area, west of Brisbane, where 16 people died and the 3 people who remain missing were lost. Many of these deaths were a result of flash flooding, which caught people by surprise. Other deaths that occurred during the flooding could have been avoided, had people exercised better judgement. Some people died while kayaking in, diving into or walking through flooded watercourses. Almost a quarter of the deaths occurred while people were trying to drive across flooded waterways.

A number of weather patterns leading up to December and January across Queensland increased the likelihood of flooding. Unusually heavy rains occurred in northern Australia during the cooler months of 2010 – normally the dry season in the tropics. This assisted in saturating the soil in the catchments. These catchments were

Source 5.15 The suburb of Fairfield in Brisbane, inundated with water from the swollen Brisbane River in the 2011 floods

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further saturated in September with widespread heavy rain. September 2010 was Australia's wettest September on record. When significantly above-average rains fell in December 2010 and January 2011, the catchments were already saturated, causing increased run-off that led to severe flooding. The most severely affected catchments were the Fitzroy River catchment in central Queensland, which included the towns of Theodore and Emerald and the city of Rockhampton; the Burnett River catchment in the upper south-east of Queensland, which flooded the city of Bundaberg; and the Brisbane River catchment in the south-east, which included the city of Toowoomba and Queensland's capital city, Brisbane.

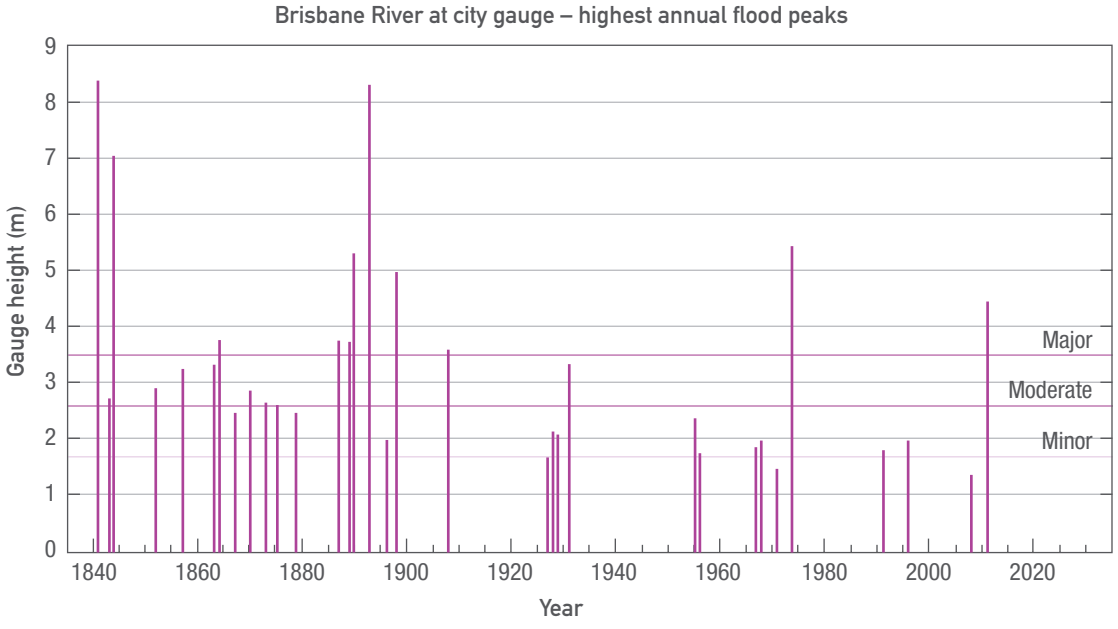
The separate experiences of Rockhampton and Toowoomba give 2 good examples of the different ways in which floods develop and how people experience them. The flooding in Toowoomba was the result of a 36-hour period of very heavy rain, which fell onto an already saturated catchment. Flash flooding occurred when a surge of water, described by the Queensland Premier Anna Bligh as an 'inland tsunami', rushed through the city centre and continued down into the Lockyer Valley, wiping out everything in its path. By contrast, the city of Rockhampton, which lies at the end of the Fitzroy River catchment, had a week to wait before the floodwaters reached their peak as the water made its way down the rivers and creeks.

While both Australia and Pakistan regularly experience floods, both countries were influenced by a La Niña weather pattern (explained later in this chapter) in 2010, and warmer than average water temperatures in the Indian Ocean, which created the conditions for the record floods that occurred in both countries.

1 Referring to Source 5.13, note the passage of the flood peak down the Indus River.

- **a** In which direction was the floodwater travelling?
- **b** On which date did the floodwater peak at the:
  - **i** Tarbela Dam?
  - **ii** Chashma Barrage?
  - **iii** Taunsa Barrage?
  - **iv** Guddu Barrage?
- **c** What is a barrage and how does it differ from a dam?

2 Compare Source 5.11 to Source 5.13. Describe the shape of the land in the most widespread of the severely affected regions. Is it flat or mountainous? How might this affect the way the floodwater behaves?



Source 5.16 Flood peaks on the Brisbane River

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3 Study a map of Queensland and locate the catchments of the Fitzroy, Burnett and Brisbane rivers. Note the number of towns and cities located in these catchments.

4 Examine Source 5.16.

- **a** Was the river height in the 2011 flood the highest experienced by Brisbane? If not, in which year was the flood peak the highest recorded?
- **b** How many times has the flood peak on the Brisbane River been recorded as being a major flood?
- **c** What was the unusual pattern in the flood peaks between 1880 and 1900 compared to other periods in Brisbane's flood history?

5 Even though the flood peaks on the Brisbane River in 1840 and 1890 were much greater than in 2011, the floods in 2011 created much more damage. Articulate why you think this was the case.

6 Investigate the impacts of the flooding in both Pakistan and Queensland. In both cases, there were short-term and long-term effects of the flooding. Copy the table below and complete as much detail as possible.

	Pakistan	Queensland
Short-term effects	• 1800 people died	• 36 people died
Long-term effects	• Mud and silt covered fertile farming land	• Agricultural fertilisers and industrial pollutants flowed into the ocean, affecting marine ecosystems

7 How does the wealth of a country affect the way its government responds to events like natural disasters? Have a class discussion about how responses to flood crises might differ in Australia and Pakistan.

La Niña and El Niño

La Niña and El Niño are 2 parts of a complex mix of sea-surface temperatures, air pressure and winds, which play a role in how weather is experienced in the countries that border the South Pacific Ocean, such as Australia. These events have also been discovered to have an influence on the temperatures of the Indian Ocean, which in turn influences the Indian monsoon.

El Niño was originally recognised by fishermen off the coast of South America, as the appearance of unusually warm water in the Pacific Ocean. Because this condition often occurs around Christmas, it was named El Niño, which is Spanish for 'boy child', referring to Jesus Christ. La Niña, meaning 'girl child', is its opposite.

In simple terms, understanding how La Niña and El Niño work comes down to understanding that there are 2 bodies of water in the South Pacific of different temperatures, one cooler than the other. In 'normal' conditions, cold water from the eastern side of the South Pacific Ocean (near Chile) pushes warm water westwards, and this warm water evaporates, feeding the formation of clouds, which bring average rainfall over Australia. During an El Niño event, the cold water doesn't push strongly enough and the warm patch of water drifts towards the middle of the South Pacific. This results in fewer rain-bearing clouds forming east of Australia, and is one of the reasons why El Niño is associated with drought. So drought years in Australia are linked to this pattern. La Niña, the opposite of El Niño, forms when the cold water in the South Pacific pushes the warm waters strongly against the east coast of Australia. When this happens, vast quantities of moisture-laden air bring above-average rainfall to Australia, and increase the likelihood of flooding and tropical cyclones.

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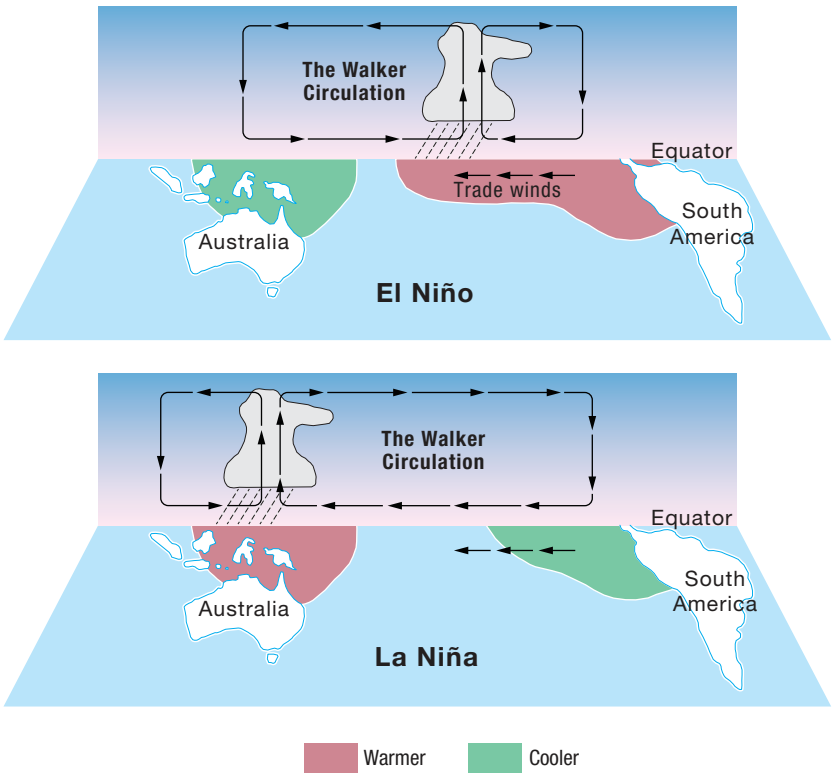
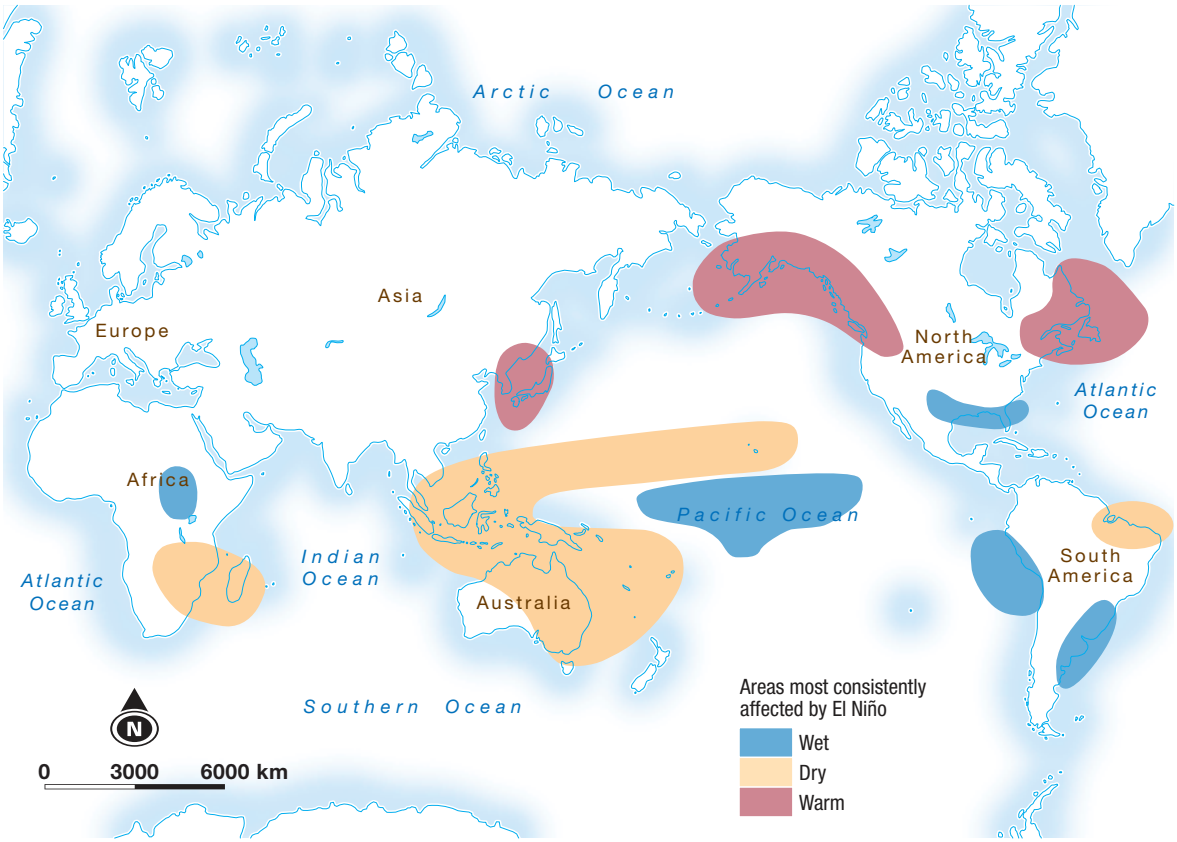


Source 5.17 The difference between the El Niño and La Niña weather patterns. El Niño brings drought conditions to Australia and La Niña brings above-average rainfall and increased cyclone events.



Source 5.18 Global effects of El Niño

ISBN 978-1-107-69012-7

ACTIVITY 5.4

1 Referring to Source 5.18 and using an atlas, identify which countries are subject to drought and which countries are subject to above-average rainfall during an El Niño event.

2 For over 150 years since the European settlement of Australia, farmers were at the mercy of a climate with a large amount of variability that they never really understood. Farmers could never reliably predict which years would be normal or which would be years of drought or flood, so activities like planting crops could be hit-or-miss. Modern meteorological science has allowed farmers to predict weather patterns more accurately. What are some of the advantages for farmers in being able to predict weather patterns?

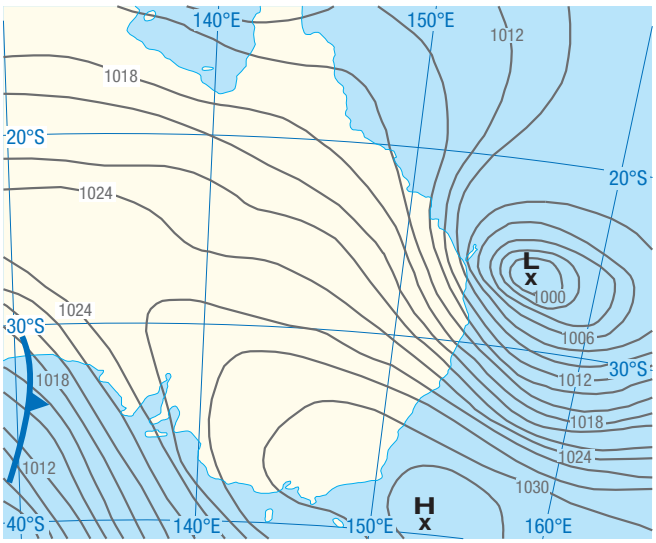
5.2 Storms

Severe storms occur more frequently than any other natural hazard, and even though they are formed by the same forces that drive the formation of other types of cloud and precipitation, they have the potential to be deadly. Severe storms produce lightning, hail, tornadoes, waterspouts, storm surges, damaging winds and intense rainfall, all of which can be very destructive. What are categorised as severe storms can range from isolated thunderstorms that affect only a few square kilometres, to intense **low pressure systems** that affect thousands of square kilometres. A low pressure system can also be associated with a tropical cyclone, which is a type of low pressure system originating over the tropical oceans.

low pressure system a weather pattern in which atmospheric pressure at sea level is below that of surrounding locations

In Australia, a typical example of a widespread intense low pressure system is that which generally forms during autumn and winter along Australia's east coast, and is known as an 'east coast low'.

East coast lows also form on the east coast of Africa and the United States. Different from tropical cyclones, these weather events do not need warm tropical seas to provide energy for them to form. And, different from isolated thunderstorms, these types of weather systems are more widespread in area. In Australia, east coast lows are created by the temperature difference between the warmer air in the Tasman Sea and cold air in the high levels of the atmosphere over the Australian continent. They are also different from tropical cyclones in that they will often intensify rapidly overnight, unlike tropical cyclones, which have life cycles of typically about a week. The speed and intensity of these low pressure systems make them one of the more dangerous types of weather systems to affect the Australian east coast, generating strong winds, heavy widespread rainfall, very rough seas and prolonged heavy swells over coastal waters, and causing damage to the coastline and posing a major threat to ships and boats. In one east coast low in June 2007, the Hunter and Central Coast regions of New South Wales were lashed with severe weather conditions. Torrential downpours and gale-force winds over 3 days caused enormous destruction, with 9 people losing their lives. Such was the force of the storm that the giant coal



Source 5.19 An east coast low

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ACTIVITY 5.5

1 On weather maps, areas of equal pressure are indicated by circular lines called isobars. In Source 5.19 an intense low pressure system is indicated by a series of closely spaced isobars that surround the centre of the system. These types of maps are also useful for determining the relative strength of winds across a region. When the isobars are closer together, this indicates stronger winds. When they are further apart, it indicates milder winds.

   Referring to the weather map in Source 5.19, note how close the lines surrounding the low pressure system off Australia's east coast are. The regions experiencing strong winds can be determined by noting where the lines touch or cross the coast. Using an atlas, identify some of the major towns and cities along Australia's east coast that would have experienced strong winds and possibly heavy rainfall.

2 Strong winds in low pressure systems like the east coast lows create heavy waves and ocean swells that pummel beaches and other coastal land formations, causing erosion and flooding of low-lying areas. What are some of the hazards that these types of weather systems pose to life and property in coastal areas?

carrier *Pasha Bulker*, buffeted by wind gusts up to 124 km/hour and heavy ocean swells, ran aground on one of Newcastle's most popular beaches. If the ship had broken up, the 700 tonnes of fuel on board would have created an environmental catastrophe.

Thunderstorms are another type of potentially severe storm. At any given moment, over 1800 thunderstorms are in progress over the Earth's surface, and about 18 million occur around the world annually. Not all thunderstorms are classified as severe – usually only 10–20% of them are. What makes a thunderstorm severe is if it has 1 or more of the following characteristics:

- rainfall heavy enough to cause flash flooding
- hail at least 20 mm in diameter
- winds over 90 km/hour.

In Australia, thunderstorms have not only contributed significantly to the drowning of 2300 people by flooding since European settlement in 1788, but have also killed over 770 people since 1824, through occurences such as falling trees and lightning strikes. Severe storms are estimated to cost on average about $284 million every year in Australia. This represents just over a quarter of the average annual cost of all natural disasters in the country. One of Australia's more costly natural

Source 5.20 The effects of coastal erosion undermining a road

ISBN 978-1-107-69012-7

disasters, in dollar terms, was a hailstorm that hit Sydney on 14 April 1999; over 20 000 properties and 40 000 vehicles were damaged by hail the size of cricket balls, which also damaged aircraft at Sydney airport. In just over an hour, this storm created over $1.5 billion in damage. The estimated total weight of the hail that fell over the city was around 500 000 tonnes.

For a thunderstorm to be created, it needs 3 main ingredients: moisture in the air, an unstable atmosphere (if you have ever been bounced around in an aircraft in flight you will know what an unstable atmosphere feels like) and a weather event such as a cold front. Like all weather, thunderstorms also need the energy of the sun to develop. Most thunderstorms in Australia occur during the thunderstorm season, which spans the warm months between September and March when the sun's energy is at its strongest. For a thunderstorm to grow, it needs warm humid air from the ground to rise in an unstable atmosphere. It is the cool air in the upper atmosphere combining with the warmer, moist air that creates this instability. The greater the instability, the stronger are the updraughts of air generated, causing the strong winds associated with severe storms. The warm air that is being forced high into the atmosphere by the updrafts contains large amounts of moisture. As it gets higher into the atmosphere, the moisture contained in the warm air begins to cool, releasing its heat, condensing and forming small water particles, which we see as cloud. As these particles are buffeted around in the updrafts, they grow in size. Eventually, the water particles are forced upwards into areas where the temperature is below freezing, and by this stage they are heavy enough to fall against the rising air. Sometimes, these water droplets turn to ice. In a severe storm this ice can fall as large hailstones, or the rainfall can be so intense and heavy that it causes flash flooding.

Thunderclouds are easily recognised, and are a sure sign that caution is needed. Looking like gigantic castles of marshmallow, thunderclouds (more technically known as cumulonimbus clouds) are towering, dark and menacing masses of circulating air that can extend 15 km from the base of the cloud to the tropopause, the part of the upper atmosphere between the troposphere and the stratosphere. The best place to be in a thunderstorm is inside, away from windows and doors. Lightning is the worst killer in a thunderstorm. If you are inside, stay away from electrical appliances; if you are outside, it is worth remembering that lightning seeks the easiest path to earth. What this means is that you need to keep yourself shorter than the nearest object that will conduct electricity. Trees are excellent conductors of electricity, so it is best to keep clear of them in a thunderstorm, even if you think they will offer shelter from the rain. Another point worth remembering is the danger from flash flooding. Avoid areas where water can quickly accumulate, such as stormwater drains in urban areas or dry watercourses in rural or remote areas.

Source 5.21 Two of the hailstones that rained down on Sydney during a violent thunderstorm in April 1999

ISBN 978-1-107-69012-7

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ACTIVITY 5.6

1. Search for a picture showing the levels of the atmosphere and draw a rough sketch. In this sketch, include a diagram showing the extent of a thundercloud within the atmosphere.
2. Explain some of the other risks associated with thunderstorms, other than drowning in floodwaters, that may cause serious injury or death.
3. Investigate why electrical appliances in your house may need to be disconnected from the electricity mains during a thunderstorm.

Case study 5.2
Canyoning

For many people who love the appeal of outdoor adventure, the lure of exploring canyons and gullies can be hard to resist. Thousands of people traipse into these flood traps every year, many of them unaware of the risks they face. A sudden storm in 1 spot can send water cascading down a canyon more than 20 km away, where it may not have rained at all, and the steep sides of canyons make them extremely difficult to get out of in a hurry.

Source 5.22 Canyoning in the Pucayacu River canyon near Banos, Ecuador

Canyoning is a form of outdoor sport in which participants use a variety of techniques, such as walking, scrambling, climbing, jumping, abseiling and swimming, to descend a canyon. It is promoted by commercial outdoor adventure companies that provide canyoning adventures to groups such as schools. However, these types of adventures have proven to have inherent risks, as has been shown by a number of fatalities occurring throughout the world. In 1 incident in 2008, 6 secondary school students and their teacher drowned while canyoning in Mangatepopo Gorge on New Zealand's North Island when flash flooding swept them away. The group, unaware of the impending threat, was trapped when a deluge struck the region, which received half the total April rainfall average in just 24 hours.

1. Evaluate why people involved in canyoning adventures need to be aware of weather in areas further away from where they are located.
2. If you were leading a canyoning adventure, what are some of the things that you would do to prepare yourself and your team for a safe trip?
3. What other adventure and extreme sport activities may involve risks from water-associated hazards? Explain what those risks might be.

ISBN 978-1-107-69012-7

RESEARCH 5.3

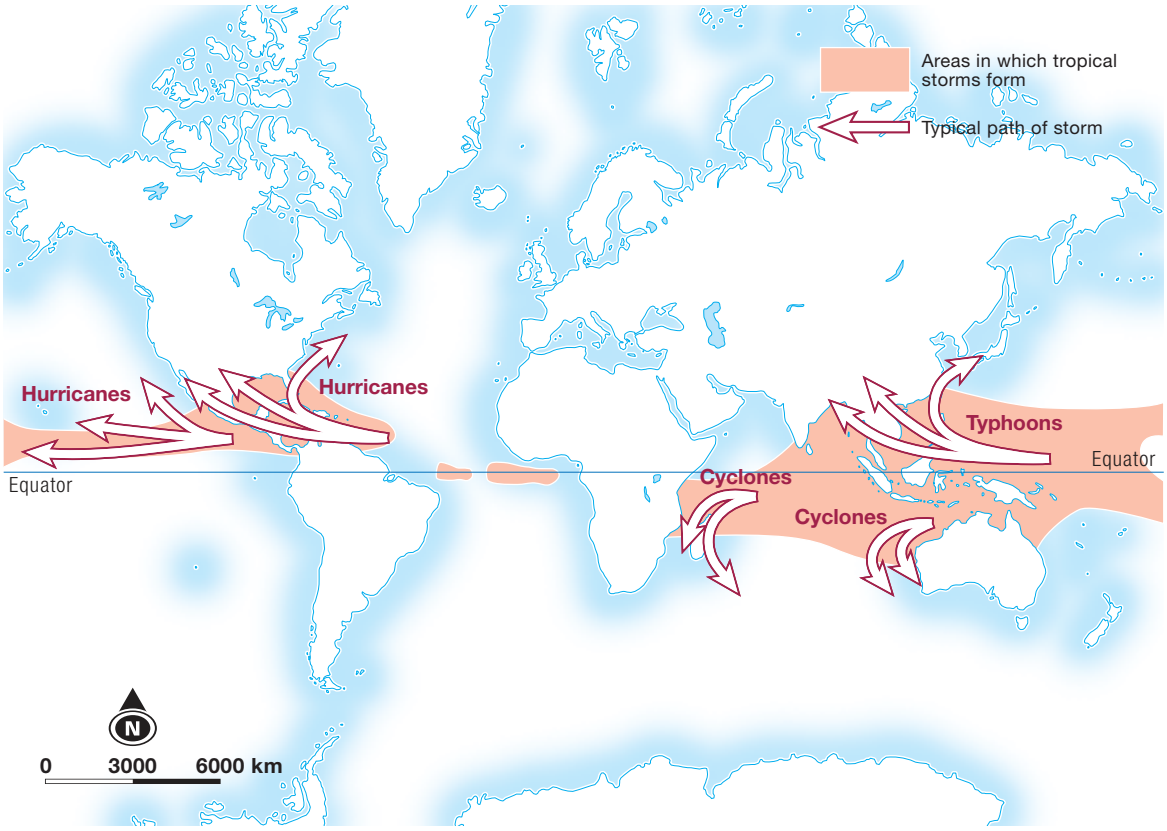
Thunderstorms are the most frequent of all Australian weather hazards, yet people are unfamiliar with ways of protecting themselves during thunderstorms. Research how to survive a thunderstorm. There are numerous websites that offer advice on what to do during a thunderstorm – both when people are outside and when they are inside. Construct a simple pamphlet titled *How to survive a thunderstorm*, designed to educate primary school children. Where possible, use symbols, graphics and photographs to get your message across.

5.3 Tropical cyclones

Around the world, about 80 tropical cyclones form every year. Some of these tropical cyclones pose enormous threats to life and property in tropical areas, such as the northern coasts of Australia to the Bay of Bengal in south Asia. You may have heard of them by their other names, which depend on where they form:

- typhoons in the western North Pacific Ocean and the South China Sea
- hurricanes in the Atlantic, the Caribbean and the Gulf of Mexico, and in the eastern North and Central Pacific oceans
- tropical cyclones in the Indian Ocean and South Pacific regions.

Much the same as a thunderstorm, a tropical cyclone needs moisture, instability and the energy of the sun to form. Tropical cyclones are areas of air that rise rapidly and rotate around a central core (known as the 'eye'). They are generally accompanied by strong winds and torrential rain.



Source 5.23 Tropical cyclones as they are known in different parts of the world

ISBN 978-1-107-69012-7

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Source 5.24 Banana plantation destroyed by Cyclone Yasi, which struck the Queensland coast in February 2011

To be officially called a tropical cyclone, they must have wind speeds in excess of 119 km/hour. While the strongest winds are near the centre, damaging winds can extend several hundred kilometres from the centre. In some tropical cyclones, wind gusts of over 360 km/hour and rainfall of 1800 mm in 24 hours have been recorded.

Clearly identifiable on satellite images as large swirling masses of cloud, tropical cyclones can cover large areas between 80 km to over 1000 km in diameter. In the Southern Hemisphere these winds rotate in a clockwise direction, and those in the Northern Hemisphere rotate anticlockwise. In the centre of a tropical cyclone is an almost calm and clear area called the 'eye'. As a tropical cyclone passes, the calmness in the eye often catches people unprepared. The calm conditions often tempt people to venture out to assess the damage and make repairs to their properties. However, the other side of the cyclone soon hits and because it continues to spin the winds now come from the opposite direction. Structures that survived the initial impact of the cyclone are often dislodged or damaged when the other side of the cyclone approaches. A cyclone lasts about 9 days, but some have been known to last for 20 days or more. Some take days to mature; others intensify within 48 hours. Cyclones are eventually downgraded to rain depressions, which result in heavy rainfall and flooding when they move over land.

Tropical cyclones need the energy provided by warm water (at least 26°C) to create the conditions for their formation, which means they generally form only in tropical waters in the summer months when the sun's energy is at its greatest. Above the warm ocean, water evaporates, rising into the atmosphere in its gaseous state to form clouds, which are bodies of condensed water. Clouds form because of the cooling of the water vapour that takes place as the moist air rises higher into the atmosphere. As the water vapour condenses, it releases the heat contained in it that made it a gas in the first place. This released heat further warms the surrounding atmosphere, making it lighter and causing it to rise higher still. This light air creates an area of low pressure, which in turn draws more moist air from the ocean, creating an ongoing cycle that increases in intensity. It is this drawing in of more moist air that creates the winds in a tropical cyclone. What makes a tropical cyclone rotate is the Earth's rotation. This rotational force is called the Coriolis effect. Once a tropical cyclone moves

ISBN 978-1-107-69012-7

over land or into the cooler waters away from the tropics, it will usually disintegrate as it loses the moisture and heat needed to fuel it.

The warm water needed for the formation of a tropical cyclone is found in the tropics, the zone between the Equator and the Tropic of Capricorn in the Southern Hemisphere and between the Equator and the Tropic of Cancer in the Northern Hemisphere. It is rare, however, to have a tropical cyclone form within 5° of the equator, because the Earth's rotational pull along this line isn't strong enough to cause the spinning force required. Therefore, there are only 7 regions in the world where tropical cyclones form. In Australia, 2 of these are off the northern Queensland and northern Western Australian coasts.

ACTIVITY 5.7

1 State the main difference between a tropical cyclone and an east coast low.

2 Find a diagram on the internet that shows how tropical cyclones form. Construct your own annotated sketch of how tropical cyclones form.

3 In which direction do tropical cyclones travel in the Northern Hemisphere – clockwise or anticlockwise? In which direction do they travel in the Southern Hemisphere?

4 Identify the name of the rotational force that causes tropical cyclones to rotate.

5 Referring to both Source 5.23 and an atlas, match the name of the country with the name used in that country to describe tropical storms. The first 1 has been done for you.

Country	Name
Fiji	Cyclone
United States of America	
Philippines	
Japan	
Bangladesh	
Madagascar	
Mexico	

6 Explain why tropical cyclones don't form in Australia's southern waters, such as off the coast of Victoria.

7 Cyclone Larry struck the Queensland coast in 2006 and destroyed 80–90% of Australia's banana crop. Reflect on what you think happened to the price of bananas following this event.

Tropical cyclone season in Australia

The tropical cyclone season in northern Australia is between November and April, with the greatest activity usually in January, February and March. Australia experiences an average of 10 cyclones per year, 6 normally crossing the coast, where they can cause significant damage. These occur mostly over north-west Western Australia between Exmouth and Broome, and over north-east Queensland between Port Douglas and Maryborough.

ISBN 978-1-107-69012-7

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ACTIVITY 5.8

1 Australian communities on the north-eastern and north-western coasts all have a history of past cyclone activity. On an outline map of Australia, indicate the following towns on Australia's north-west coast and label them. In your legend, make note of the years that these towns have been hit by significant cyclones. Remember to give your map a heading.

Town or city	Years of notable cyclones	Average time between cyclones
Broome	1910, 1926, 1935, 1957, 2000	18 years
Onslow	1880, 1897, 1909, 1918, 1934, 1953, 1956, 1958, 1961 (3 times), 1963, 1965, 1975, 1995, 1996, 1999, 2006	
Carnarvon	1839, 1893, 1916, 1921, 1934, 1937, 1943, 1953, 1960, 1970, 1975, 1979, 1988	

2 Using the information in the table above, calculate the average number of years between significant cyclones striking each town. The first has been done for you. To calculate the averages, determine the number of years between the first and last record and divide it by the number of cyclones that have occurred. For instance, for Broome there was a period of 90 years between the first recorded cyclone and the last. Divide 90 by the number of cyclone events, in this case, 5. This gives you a figure of 18 years. Which town is more likely to be hit by a cyclone in the next 10 years?

3 On the same outline map, locate the following towns and cities on the Queensland and Northern Territory coast: Darwin, Cooktown, Cairns, Townsville, Mackay and Rockhampton.

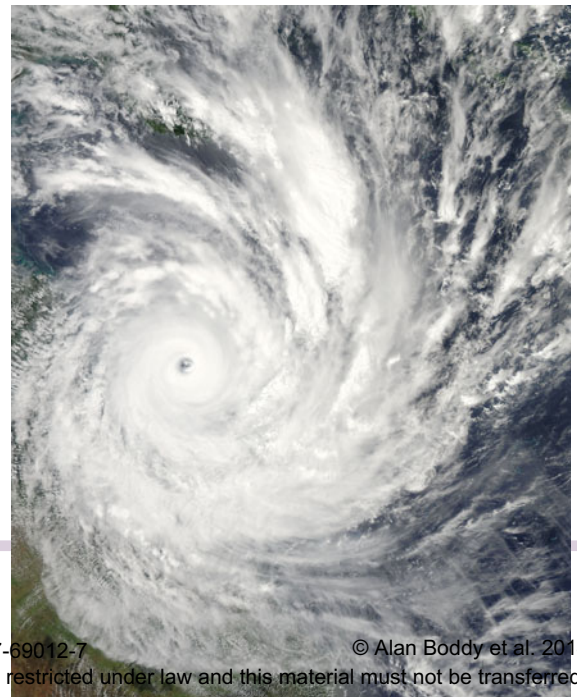
4 Go to the Australian Bureau of Meteorology website (you'll find a link at www.cambridge.edu.au/geography7weblinks) and open the page for tropical cyclones. On this page you will find a section on previous cyclones. Find the record for the following cyclones and map their paths on your outline map.

a Cyclone Yasi – 2006b

b Cyclone Monica – 2006c

c Cyclone Larry – 2006

d Cyclone Ingrid – 2005



Source 5.25 Satellite image of Cyclone Yasi crossing the Queensland coast in February 2011. Note the 'eye' of the cyclone.

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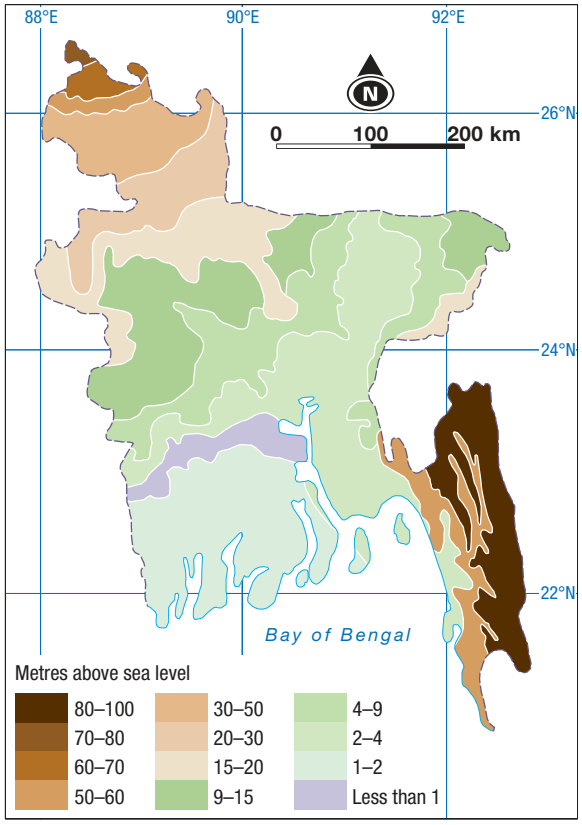
Dangers from a tropical cyclone

Notwithstanding the damage caused by the strong winds, much of the destruction wreaked by a tropical cyclone is a result of flooding from storm surges and torrential rain. A storm surge is simply water that is pushed towards the shore by the force of the winds swirling around the cyclone. A storm surge doesn't behave like a normal wave hitting the shore like those you see at a beach like Bondi Beach. The strong winds and the area of low pressure in the eye of the cyclone create a raised dome of water, which can be 50 km or more across and several metres high. When it hits the shore it can last for several hours. The storm surge moves with the forward speed of the cyclone – typically 15–25 km/hour – and has tremendous power. A 30 cm deep storm surge can sweep a car off the road, and even in a 15 cm surge it is difficult for a person to remain standing. The destructive power of the rushing water is compounded by the large amount of floating **debris** that typically accompanies the surge. Trees, pieces of building material and other debris float on top of the storm surge and act as battering rams that destroy anything in their way. When this advancing surge combines with the normal tides it creates a storm tide, which can increase the average water level by 10 metres or more. An even greater danger occurs when a storm surge coincides with a higher than average tide. Areas of low-lying coastal land are at risk from extensive flooding in a storm surge, which can push inland for tens of kilometres. Much of the devastation caused to New Orleans in the United States by Hurricane Katrina in 2005 was due to the inundation that occurred when an 8 metre high storm surge broke through the protective levees surrounding the city. Over 1800 people died in this disaster. The vulnerability of the city to tropical cyclones was heightened because many areas of the city are between half a metre and 2 metres below sea level. It is this same vulnerability that makes a country like Bangladesh so exposed to the threat of tropical cyclones. Much of the Bangladesh landmass is less than 3 metres above sea level.

debris the remains of something that has been destroyed or broken up



Source 5.26 Relief map of Bangladesh. Note the low elevation of most of the country. This makes Bangladesh extremely susceptible to river flooding, storm surges and sea level rises.

ISBN 978-1-107-69012-7

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Situated in a region of high cyclone activity, Bangladesh regularly experiences devastating storm surges that push far inland, threatening the densely populated communities that rely on the waters of the major rivers and the rich alluvial soils of the flood plains for farming.

The other feature that makes tropical cyclones so destructive is that they can produce heavy rainfall over extensive areas. Along the coast where the cyclone has struck, the heavy rainfall combines with and accentuates the saltwater inundation from storm surges, creating greater damage. The rainfall from tropical cyclones doesn't just affect coastal areas where the cyclone has struck, but is often even more intense further inland. When a cyclone moves over land it loses its source of power – heat and moisture – and becomes a wide belt of low pressure. When this happens, it begins to lose its capacity to retain the moisture locked up in its system, and releases it. Often this happens far from where the cyclone struck land. Some of the biggest flooding events in Australia have been caused by decaying tropical cyclones. The Brisbane floods in 1974 were caused by the decaying Cyclone Wanda.

ACTIVITY 5.9

1. Discuss why people should not venture out of shelter when the winds immediately subside during the passage of a cyclone.
2. In the Northern Hemisphere, hurricanes are rated by the Saffir–Simpson Scale. Describe, using the library or the internet how this scale categorises hurricanes. What scale is used in Australia to categorise tropical cyclones?
3. In 1974, Cyclone Tracy devastated Darwin, the capital of Australia's Northern Territory. A famous song written about the event is called 'Santa never made it into Darwin'. What is the title of the song specifically referring to?
4. One of the important roles of meteorologists is to track the paths of tropical cyclones so that advanced warning can be given to communities to prepare for them. The Australian Bureau of Meteorology website provides an interactive example of how cyclones are tracked, and a link to this is provided at www.cambridge.edu.au/geography7weblinks.
5. Imagine that you live in a town like Broome or Townsville on Australia's northern coast and have received advanced warning of a tropical cyclone forming. What preparations might you take to get ready for the possibility that the cyclone might hit your region?
6. Evaluate why tropical cyclones are still a hazard once they pass over land and lose the energy they need to fuel them.

Tsunamis

Storm surges associated with tropical cyclones are one cause of saltwater flooding of coastal communities. The other major threat for coastal communities is that posed by tsunamis. Although a much rarer occurrence than storm surges, tsunamis have the potential to cause massive destruction and loss and life, as was the case in the Indian Ocean tsunami in 2004, which killed an estimated 230 000 people in 14 countries bordering the Indian Ocean, and the Japanese tsunami of 2011, which killed approximately 20 000 people and destroyed several nuclear power reactors, almost triggering a nuclear disaster.

Tsunami is a Japanese word based on 2 elements: *tsu* meaning 'harbour' and *nami* meaning 'wave'. The term was first used several centuries ago by Japanese fishermen who came back from sea to discover that the harbour they

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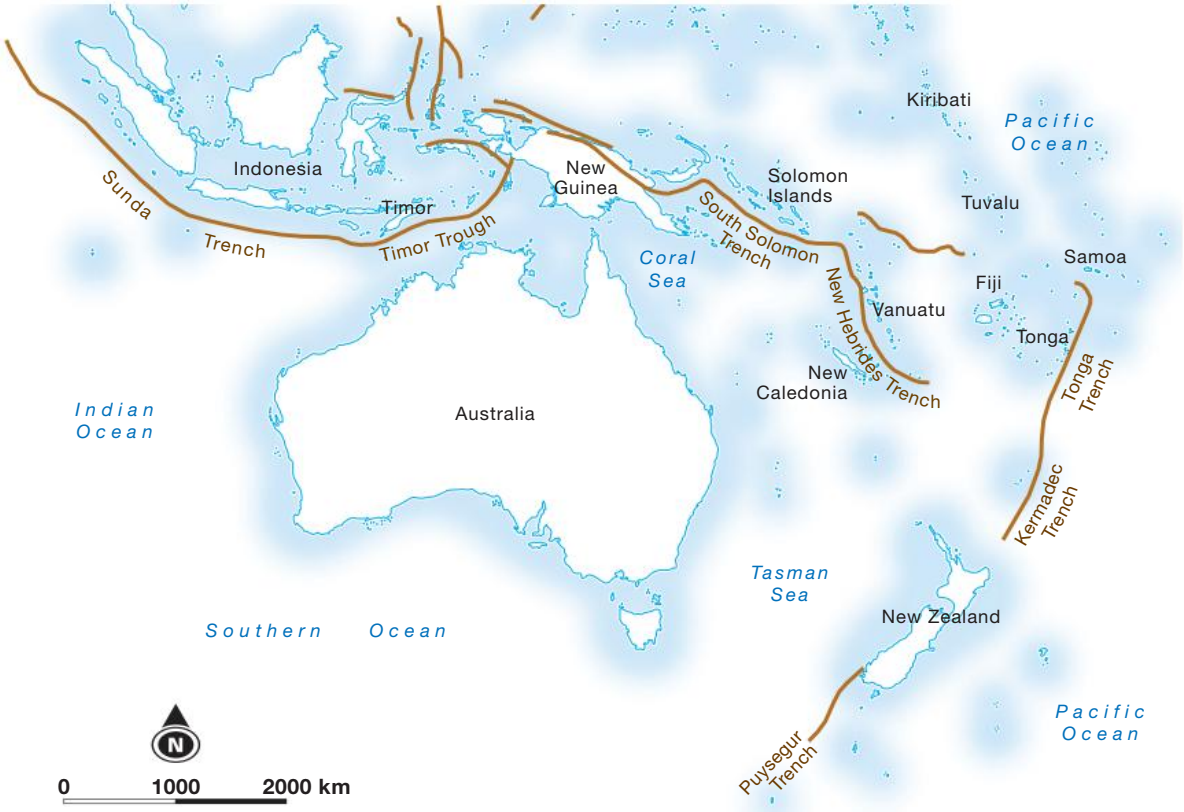

Source 5.27 The solid lines indicate locations of earthquake fault lines in Australia's region that pose a tsunami threat to Australia.

had set out from had been devastated by waves, even though they hadn't experienced a cyclone or noticed any unusual wave activity while out at sea. Tsunamis are generated by sudden changes in the sea floor through undersea earthquakes, landslides or volcanoes or, rarely, through a wave generated when a meteorite hits the ocean. They begin as broad, low ripples in the open sea, often passing unnoticed beneath ships, which feel only a gentle swell. They are different from wind-generated waves, which cause movement of water only near the sea surface. By contrast, tsunamis create water movement right down to the sea floor. They are incredibly fast, travelling across deep water at more than 900 km/hour – the speed of a jet aircraft. When they reach shallow water along the coast, they slow down and begin rising to a terrifying size – sometimes up to 60 metres high. Waves during the Indian Ocean tsunami in 2004 had heights of less than 2 metres in the open ocean but ran up to heights of 10 metres above sea level along many coasts, even though they were thousands of kilometres from the earthquake. One of the signs of an impending tsunami hitting the coast is that water is usually drawn hundreds of metres away from the shore before the tsunami arrives. Unaware of what they are observing, people who come to look at these strange sights are often swept away when the wave suddenly rears up out of the sea.

Source 5.28 A fishing boat lies 2 km from the sea after being swept ashore in the 2011 Japanese tsunami, which killed approximately 18 000 people.

ISBN 978-1-107-69012-7

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The Australian coastline has experienced tsunamis throughout its recorded history, but most have not been of significant magnitude to create a serious issue for coastal communities. While the overall risk from tsunamis to the Australian population is lower than it is for many other parts of the world, the threat to coastal communities in Australia still exists; while the Australian landmass itself isn't sitting on active tectonic plate boundaries where earthquakes occur, it is surrounded to the north and east by about 8000 km of these boundaries. Any tsunamis that were generated would reach Australia within 2–4 hours. The Western Australian coast is particularly exposed to earthquake activity in the Indian Ocean, for instance. In July 2006, isolated sections of the northern Western Australian coast were hit with a significant tsunami surge resulting from an earthquake off the coast of Java in Indonesia. The tsunami caused widespread erosion of roads and sand dunes and extensive vegetation damage, and destroyed several campsites up to 200 m inland.

Geographical fact

There have been moments in Australia's history when freak waves have swamped the Australian coast on clear, calm days. One notable example was the event known as 'Black Sunday', which occurred on 6 February 1938 at Bondi Beach in New South Wales. Witnesses described this event as successive waves that piled water on the beach and swept swimmers out to sea in the backwash. An estimated 250 swimmers were swept away in the surging waters and 5 people drowned before surf lifesavers could rescue them. It is speculated that this 'mini tsunami' was caused by a small, localised submarine landslide.

RESEARCH 5.4

Australia has a tsunami warning system in place to warn of the impending danger to the Australian coastline. Go to the Australian Bureau of Meteorology website (see the link at www.cambridge.edu.au/geography7weblinks) and investigate how the tsunami warning system works. Create an annotated poster showing how the tsunami warning system works.

5.4 Drought

The duration of most weather hazards is relatively brief. Cyclones will last a couple of hours before moving on, and the duration of floods can usually be measured in days – but not so with drought. Drought is one weather extreme that's defined not by what happens, but rather by what doesn't happen – namely, rain. At its most deadly, drought presents the most serious physical hazard to crops and pastures in nearly all regions of the world. This is a hazard that can go on for decades and its effects can last for generations, so that soils become so depleted of their fertility that crops are less likely to grow even after the drought has ceased.

The simple definition of drought is a lack of normal rainfall over an extended period of time, although the causes of drought can be much more complex, such as higher than average temperatures causing abnormal evaporation and transpiration. Drought differs from aridity, which is a permanent feature of climate in regions with low rainfall. Many

ISBN 978-1-107-69012-7

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Source 5.29 Dust storm in a Somali refugee camp in Kenya, East Africa in 2011

of the dry inland areas of central Australia would be classified as arid because of normally low average rainfall. **Meteorologists** typically determine when a region is suffering drought by comparing the current patterns of rainfall to an average based on a 30-year period of records. Even areas that get regular rainfall can experience drought. Drought, for instance, may occur in the headwaters of a major river catchment that is used for irrigation, thus causing crop failure in an irrigated region hundreds of kilometres downstream – possibly even in another country – that relies on the water flowing down the river. Such was the case of drought experienced in the Nile delta in Egypt when rains failed to fall in the Ethiopian highlands, even though the delta itself received regular rainfall.

meteorologists people who study weather and climate

Unlike other weather hazards that people can see happening before their eyes, such as heavy rainfall or surging water, drought is a slowly evolving menace that is usually only clearly perceived through its effects: water supplies dry up, crops fail to grow, animals die, dust storms blow away the precious top soil, and in poorer countries of the world malnutrition and ill health become widespread when people's normal sources of food no longer exist. Some of the most evocative pictures of drought are illustrated in communities in East Africa such as Sudan and Somalia, where drought and famine have etched misery into the faces of people over generations.

So drought is more than a physical phenomenon; it has significant impacts on communities on national, regional and local scales. The agricultural sector is usually the first to be affected by drought. On a national scale, in developed countries like Australia this becomes reflected in higher food prices because of diminishing supplies of basic foods such as grains, fruit and meat. On a local scale the impact on rural communities in drought-stricken areas is also significant, with the lack of economic activity causing businesses to close and people to leave the district. Drought has other economic impacts on human communities also. A shortfall in the water supply, for instance, can disrupt the production of hydroelectric power, thus affecting businesses and industries reliant on electricity. A drought in Uruguay in 1988–89 resulted in a significant decline of hydroelectric power because the lack of rainfall disrupted the stream flows that were needed for electricity production. Drought also has an impact on people's sense of wellbeing, changing the landscape of towns and cities when parks and gardens suffer from lack of water, and trees and plants die, such as happened across cities and towns in Australia during the prolonged droughts in the first decade of the twenty-first century. One of the other side-effects of drought that is particularly hazardous in Australia is an increased risk of bushfires.

ISBN 978-1-107-69012-7

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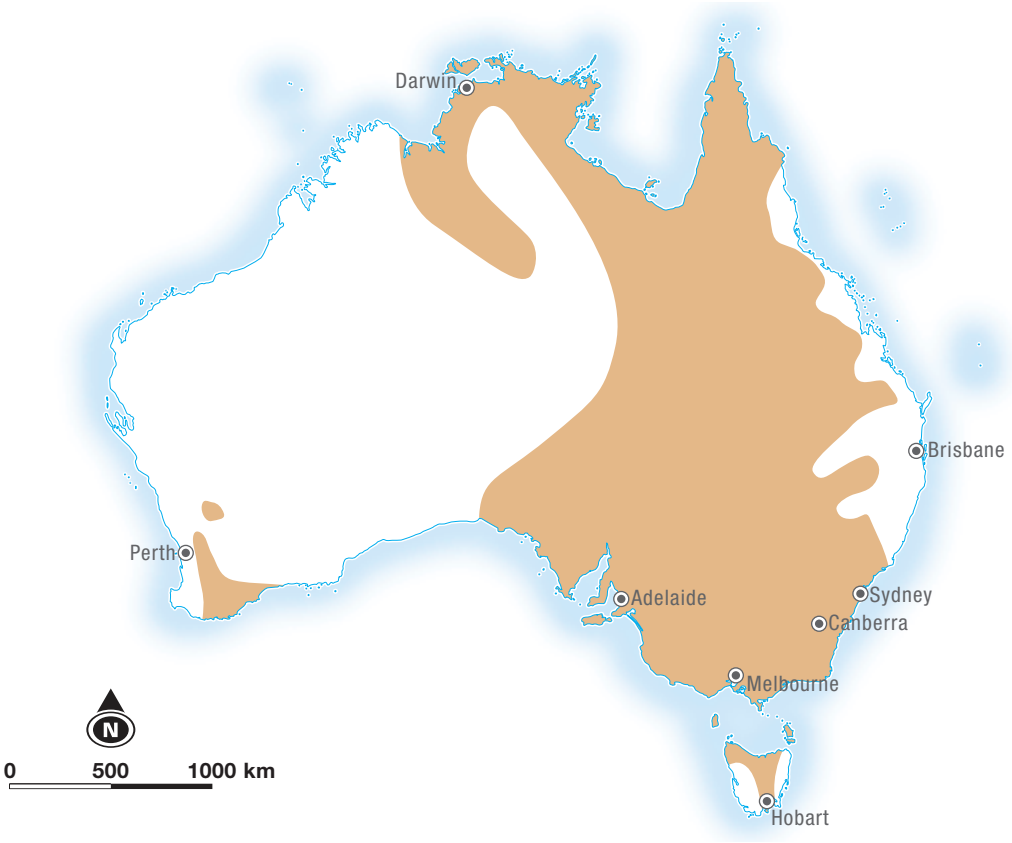

Source 5.30 Areas suffering El Niño-related drought across eastern Australia in the 11 months preceding the Ash Wednesday bushfires in February 1983

The Ash Wednesday bushfires that devastated regions of Victoria and South Australia in 1983 were preceded by an 11-month drought that was linked to El Niño and affected most of the eastern half of Australia.

It is in the poorer regions of the world, such as East Africa, where drought can be at its most devastating. Over the last 20 years, ongoing drought in East Africa has killed millions of people through hunger and disease, and dust storms that have blown away the precious topsoil have reduced the fertility of the soil to such an extent that even in periods of regular rainfall the soil has lost its capacity to grow sufficient food for its populations.

ACTIVITY 5.10

1. Identify the links between drought and the increased incidence of major bushfires in Australia.
2. Discuss whether arid regions can experience drought.
3. Major droughts in East Africa are called humanitarian disasters because of the widespread nature of the problem and the high numbers of people affected. During these major catastrophes, aid agencies like Oxfam and Médecins Sans Frontières do vital work in providing basic services such as food, shelter and medicine to the affected people. Evaluate the work of aid agencies during natural disasters.

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5.5 The effects of a changing climate

Climate scientists still don't know for certain how the future effects of a changing climate are going to directly influence extreme hydrological events such as floods and droughts, but there is increasing evidence that a warming climate causes greater evaporation and surface drying in various regions around the world like Australia and East Africa, and that this will lead to the increasing intensity and duration of drought. This increased evaporation will also put greater moisture into the atmosphere, influencing both the incidence and the severity of storms and tropical cyclones. Recognising these changes as a global pattern will mean that areas that are already dry, such as many farming areas in Australia, will get drier on average, and areas that are already wet, such as the tropics, will get wetter. Climate scientists using powerful computers to model extremely complex weather and climate information have also suggested that the severity of rainfall and drought events will increase. This means that droughts in areas such as Australia will last longer than they have done on average and will occur more frequently, and that rainfall events such as the one that affected Queensland and many other parts of Australia in 2010–11 will be much more severe, creating greater flood risk.

The other way in which **climate change** will influence water-associated hazards is in the threat of inundation from rising sea levels. Global warming is melting ice that has been locked away for hundreds of thousands of years in the polar regions and in mountain glaciers. These melting bodies of ice, which are increasing the volume of the world's oceans, are predicted to raise sea levels 0.5–1 metres over the next century. Humans are therefore vulnerable to increased hazards in the coastal zones. Many of the world's largest cities and industrial facilities are located on the coast, and one-quarter of the world's population lives within 100 km distance and 100 metres **elevation** of the coastline, with significant increases in the number of people living in coastal regions expected over the next 50 years. Impacts included sea-level rises, a higher risk of exposure to extreme water-associated events such as intense storms, storm surges and flooding, and the threat of saltwater contamination of freshwater resources and farmland.

climate change a gradual change to the world's normal climate state that may affect the future of the planet

elevation height above sea level

Source 5.31 A polar bear leaps between melting ice floes.

ISBN 978-1-107-69012-7

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ACTIVITY 5.11

1. Earlier in the chapter you were asked a question about how flood maps help local governments plan development in their areas. Explain how climate change might affect the accuracy of these maps.
2. Discuss how increased frequency and severity of drought might influence food prices in Australia.
3. Analyse why saltwater contamination of farmland might be an issue for farmers.
4. The tiny island nation of Kiribati in the central Pacific Ocean is expected to be the first country where all land territory disappears because of sea-level rises linked to climate change. List some other island nations where sea-level rises will have a critical impact in the next 50 years, and show these on an outline map of the world.

Source 5.32 Sandbags provide little protection against rising tides on Kiribati Atoll.

RESEARCH 5.5

Imagine that you are a resident of one of the island nations that are threatened with inundation from sea-level rises linked to climate change. Write a letter to the General Secretary of the United Nations justifying why the world community needs to reduce carbon emissions. In your letter you need to explain what is happening to your country, what impact this threat is having on your life and how it makes you feel about the future.

ISBN 978-1-107-69012-7

Chapter summary

- Hazards associated with water include a wide range of phenomena, from floods and drought to severe storms, tropical cyclones and tsunamis. Unlike other hazards such as earthquakes that are regionally specific, water-associated hazards affect communities all over the world.
- Globally, floods are the most destructive frequently occurring natural event, but they are also a part of natural environmental cycles, which are needed to ensure the health of ecosystems.
- Communities around the world have learned to live with water-associated hazards, but as populations are increasing around the world in areas such as flood plains and in coastal areas, the risk that these hazards pose to communities is increasing.
- Climate change is predicted to increase the frequency and magnitude of water-associated hazards such as floods, droughts, severe storms and tropical cyclones.

End-of-chapter questions

Multiple choice

1 Hydrology is the scientific study of _____.

A tropical cyclones
B earthquakes
C disasters
D water

2 Which of the following is not a side-effect of drought?

A Rising food prices
B Increased incidence of bushfire
C Dust storms
D Sea-level rise

3 In Australia, a tropical storm is known by what term?

A Cyclone
B Hurricane
C Typhoon
D East coast low

4 Which of the following events is required for a thunderstorm to be classified as severe?

A Rainfall heavy enough to cause flash flooding
B Lightning
C Thunder
D All of the above

5 Which of the following Australian cities is most likely to experience a tropical cyclone?

A Melbourne
B Sydney
C Darwin
D Hobart

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Short answer

1 Discuss the effect El Niño and La Niña events have on Australian weather patterns and how these affect Australian communities.

2 Identify what factors other than rainfall lead to flooding.

3 Describe how the shape of the land affects the behaviour of floodwater.

4 Examine why floods are an essential part of ecosystems.

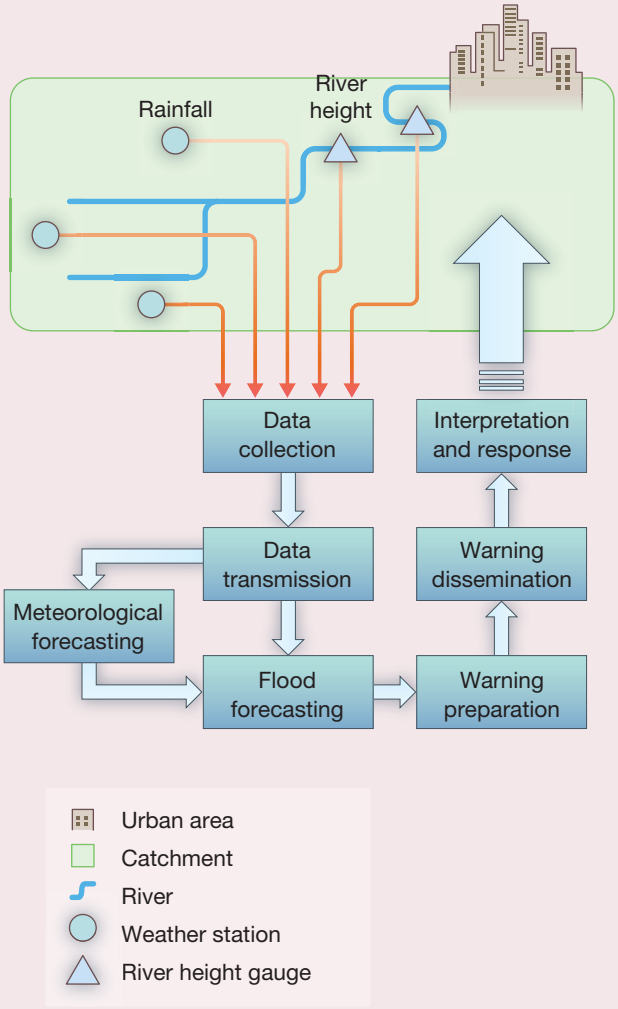
5 Explain why expected population increases in coastal areas over the next 50–100 years are going to make the management of water-associated disasters more difficult.

Extended response

When an emergency such as a flood threatens a region, a coordinated response needs to take place so that the safety of people and the protection of property can be maximised. Source 5.31 shows how an emergency management system works during a potential flood crisis. Who do you think might be involved at each step and what sort of actions might take place?

Meteorological organisations such as the Commonwealth Bureau of Meteorology in Australia monitor weather conditions like rainfall and river height. This information is collected and forecasts are made, such as the chance of further rainfall and the behaviour of the floodwater in the catchment. The information is then passed on to emergency and government organisations like the police and government emergency management coordinators. This information is then collected and emergency management plans are set in place. Warnings are sent out to communities and preparations are made to deal with the crisis.

Create a disaster emergency plan for the town or city that you are located in and present it as a brochure. If you live in a community that does not suffer the threat of flooding, describe another threat such as a bushfire or tropical cyclone.



Source 5.33 An emergency management system during a potential flood crisis

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UNIT 2
Places and liveability

ISBN 978-1-107-69012-7

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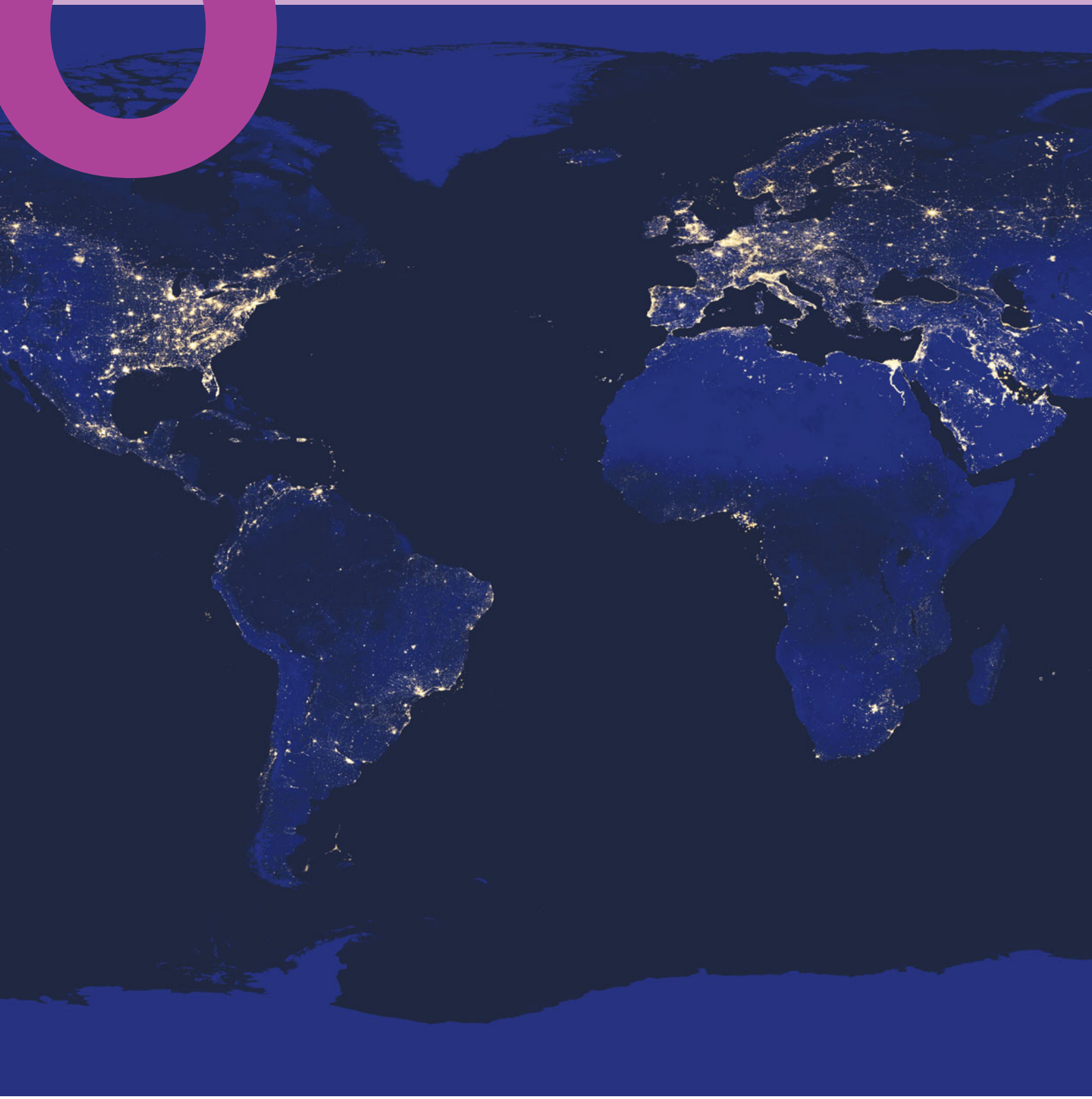
6 Settlement



Source 6.1 The Earth at night – a series of satellite images compiled by NASA

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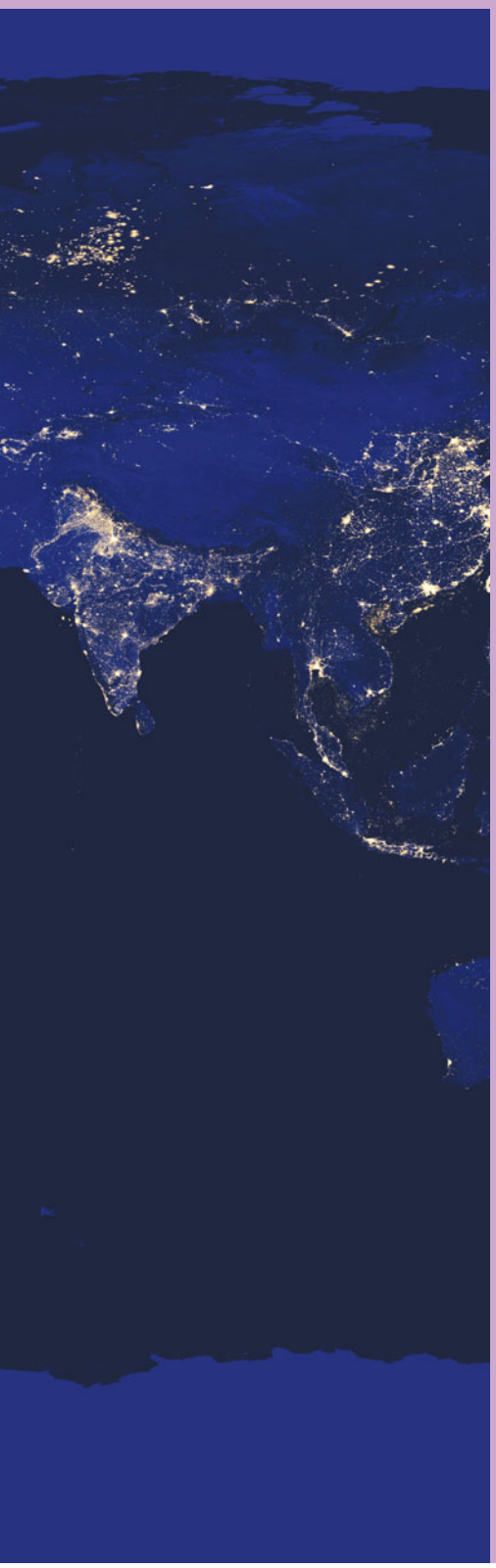

Before you start

Main focus

Liveability can be assessed by the function, size and location of different settlements.

Why it's relevant to us

All human settlements need to be liveable and governments need to plan for the needs of their community.

Inquiry questions

- What factors influence where people live?
- How remote is too remote?
- What resources, services and facilities do cities need?
- Which cities have dominant functions and why?
- What is liveability?

Key terms

- Centrality
- Community
- Functions
- Infrastructure
- Liveability
- Remoteness
- Settlement
- Specialisation of labour

Let's begin

Settlements vary in size, but all have a few things in common. They all comprise different communities (or may be one small community in themselves); they need services, resources and facilities to function effectively; they all have challenges in meeting the needs of the population; and they all rely on another settlement to some extent. In the future, you will need to think about where you will choose to live and why you would live there. A range of factors will influence your decision.

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6.1 People's place of settlement

Communities

community a group of people sharing the same locality or similar interest

A human **community** is a group of people that share the same interests, place or space. Communities can be very small, like a tiny village of 100 people, or very large, like the international community. Each community has a goal of achieving what is best for that group in that setting. There are many different communities in and around Australia, for example:

- sporting groups, such as soccer clubs and netball clubs
- skill-based communities, such as music groups and art and craft centres
- mothers' groups and play groups, such as the Crows Nest Community Centre, Sydney
- your school community
- ethnic groups, such as the Vietnamese community
- religious groups, such as the Muslim community.

Environmental and socio-cultural factors

Many factors influence where people live:

- *Environmental constraints.* Steep hills, muddy and unstable ground or arid regions tend to restrict the numbers of people living in those areas due to potential hazards and hardship. Inland Australia is one of the most sparsely populated areas in the world (with a density of fewer than 2 people per square kilometre) especially when compared to a country like Hong Kong, which has 500 people per square kilometre.
- *Land availability.* In densely populated countries, some people construct makeshift homes wherever they can find a space. For example, in Bangkok, Thailand, there are markets and homes that occupy space less than a metre from train tracks. When a train comes through,

Source 6.2 Prime real estate on the Sydney waterfront

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people simply move aside and wait for it to pass, then continue shopping or going about their business. In Halong Bay, Vietnam, people have built houses that float on water (not quite like a houseboat).

affordability the extent to which commodity such as housing can be afforded

settlement a settled community

- **Affordability**. This is a big factor in determining where people can live. The most expensive postcode in Australia is Point Piper near Double Bay in Sydney. Very few people can afford to live there because the median house price is $8.5 million. A mix of housing types, such as units, semi-detached houses and small dwellings, is required to be built in most **settlements** to ensure everyone has a chance to live in a reasonable condition.

kin people closest to you related by blood; kinship usually refers to family

- *Proximity to relatives (nearness to* **kin***).* Many people choose to live either with their families or close to relatives. By doing this, they gain a sense of security, familiarity and support.
- *Job location.* Depending on where people are employed, they may choose to live close to work because it means they don't have to spend hours commuting each day. However, some mining companies have solved this problem by providing flights in and out of the mining areas in Western Australia for their workers.
- *Environmental quality.* Pristine environments are sought after. People like to live in nice, non-polluted areas where soil is not degraded and they can enjoy the scenery or the outdoors as they wish.
- *Connection to a place.* Some people feel a special connection to the place where they grew up or enjoyed spending time, and choose to go back and live there. For instance, Indigenous Australians have cultural connections to their land, and so may choose to live in certain areas.

Geographical fact

Antarctica is the only continent without an indigenous community.

ACTIVITY 6.1

1. Interpret the term 'community' and provide 5 examples of different communities near you.
2. Explain 3 reasons why you live where you do.
3. Describe how connection to place influences where some Indigenous Australians live.
4. Examine the role of affordability in influencing where people live.

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RESEARCH 6.1

Conduct an internet search for images of the Earth at night by NASA. Use the images to zoom in for a more detailed view to help you answer the following questions. You may also need to look at other maps and atlases that show natural and human features.

1 Which areas or countries of the world are clearly defined?
   - **a** Are these developed or less-developed countries?
   - **b** Identify 3 islands you can see.

2 Where do cities tend to be located?
   - **a** Are most of the cities on the coast or inland? Provide reasons for their location.
   - **b** Identify 3 significant cities in the Northern Hemisphere and outline similarities between them, such as their function and features.

3 Examine the darker areas of the continents. Why are these so dark? Use examples of countries and the following ecosystems in your answer.
   - **a** Rainforests
   - **b** Hot deserts
   - **c** Cold deserts
   - **d** Alpine regions
   - **e** Polar regions

4 Examine the patterns and lines created by lights. Name the location and explain how the following features have influenced human settlement:
   - **a** a famous river (hint: zoom in on Africa)
   - **b** a famous railway line running through the continent (hint: zoom in on Asia)
   - **c** a major mountain range
   - **d** coastlines.

5 *Extension:* The brightest areas of the Earth are the most urbanised, not necessarily the most populated. Evaluate this statement using examples.

6.2 Environments conducive to settlement

Some environments are considered easier to live in than others. Environments with extreme conditions, such as high or low average temperatures, require special clothing, housing, technology and **infrastructure** for people to survive. Generally, the more extreme the environment, the less likely it is people will live there. However, communities in extreme environments, such as deserts or polar regions, have some of the most interesting and unique social and cultural practices, and it is good to learn and know about them. Environmental factors that influence where people live can include climate (temperature, wind and rainfall) and topography (geology and gradient).

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services and education systems

The International Union for Conservation of Nature (IUCN) makes the following statement:

> Many of the natural environments most **conducive** to human settlement are linked inextricably to natural hazard exposure. A map of human population distribution across the globe shows that we are concentrated in the tropics and mid-latitudes, but not evenly so. Human settlements clump along continental coastlines, generally leaving the centres of large continents less populated. Human settlements are sparse and small in the most mountainous regions, but are prevalent along the foothills of these ranges. The banks of major river systems are crowded with some of our oldest permanent human settlements.

conducive favourable, helpful

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Source 6.3 Factors affecting settlement patterns

Factors affecting settlement patterns	Environments conducive to settlement	Environments not conducive to settlement
Temperature	Mild temperatures found in the mid-latitude countries. Summers are warm and winters are cool, providing a nice seasonal variation that is not too uncomfortable.	Extreme heat around the tropics, but particularly in arid areas, restricts human activity so settlements tend to be more active at night when temperatures fall. Arid areas have an interesting array of wildlife, but it is rarely enough to sustain permanent human populations; this is why desert communities are often nomadic. Extremely cold environments at the poles or at high elevations have the opposite problems and people need to adapt in other ways.
Wind	Gentle breezes and sea breezes are sought after in settlements, as they can often cool things down on a hot day and provide relief to people.	Strong winds all year round are not good because of the wear and tear and potential hazards they cause around facilities and infrastructure. Antarctica is generally considered the windiest place on Earth, so with wind combined with extremely low temperatures, it is not ideal.
Rainfall	Moderate rainfall is preferable for settlements, such as in mid-latitude countries from about 23° to 66° north and south of the Equator. An ample supply of freshwater is required for settlements.	Extremely low rainfall in arid areas, usually on the western side of continents or inland, often deters people from settling there, because so much water is used in agriculture and industry and for domestic purposes each day. However, Phoenix, Arizona is 1 exception: this large city was built in the desert and uses more water than is naturally supplied because water is piped in from the Colorado River, and the city uses groundwater and recycled water. Too much rainfall can limit human activity and cause flooding.
Geology	Areas of fertile land are preferable to settle in because farming and cultivation can take place near housing. This was a primary concern in many cases when communities were established.	Extremely sandy soils are an indicator of a lack of freshwater, and there are limited numbers of plants and animals there to sustain a settlement. Similarly, extremely rocky areas, particularly those with granite, are difficult to settle because of the impossibility of constructing housing.
Gradient	A low gradient, or flat ground and gentle slopes, are preferable to build houses, roads and other facilities on because they keep the cost down, and water can still be drained away. However, some people want to construct houses on steep slopes because they get better views.	Steep slopes make the cost of building higher because cutting into a hill may have to take place, or pylons may need to be constructed to hold up houses. However, some communities settle on very steep slopes because they have no other options. Usually, these are slum dwellers living a precarious existence, for example the inhabitants of Mount Elgon in Uganda.

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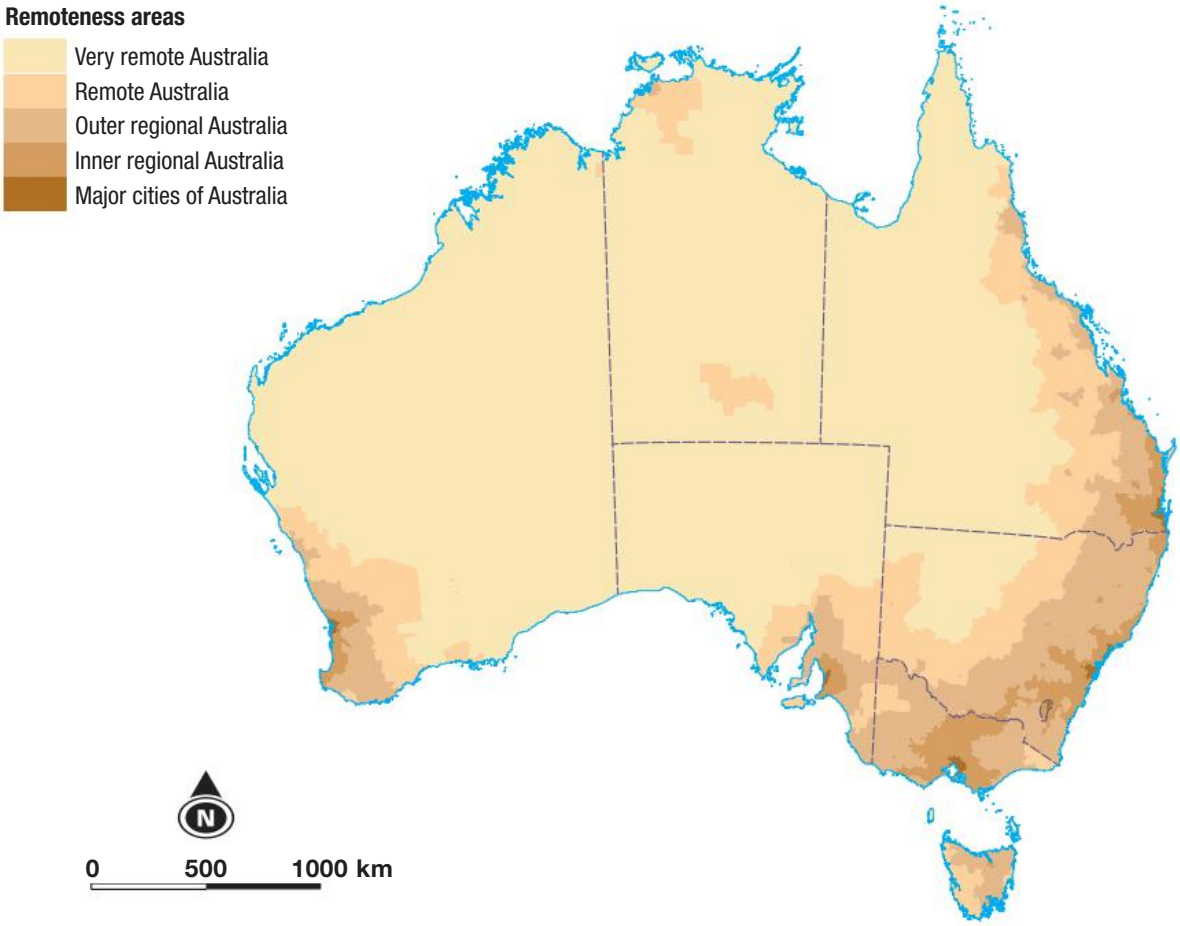
Remoteness

remoteness distance, a very distant situation

The concept of **remoteness** in Australia refers to how far away something is. There is a difference between how far people have to travel by road in a city for access to goods and services as compared to distance that people have to travel in the country. However, the distinction between city and country areas is often unclear. The Australian Bureau of Statistics (ABS) has developed an Accessibility/Remoteness Index in order to make data collection and classification of areas in Australia easier. Different groups of people have different perceptions about remoteness and this affects where they are prepared to live.



Source 6.4 The ABS 2006 remoteness structure

Geographical fact

26% of Indigenous people live in remote Australia and highly remote Australia, and 31% live in the major cities of Australia.

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ACTIVITY 6.2

1 List some factors that make it easier for settlements to be established.
2 Describe the global trends in settlement patterns.
3 Account for state capitals being located where they are.
4 Explain how remoteness is defined by the Australian Bureau of Statistics.
5 Use the map showing remoteness (Source 6.4) and an atlas to classify the following settlements using the table below.

- Broome
- Cobar
- Rockhampton
- Bairnsdale
- Tennant Creek
- Yulara
- Freemantle
- Katherine
- Dubbo
- Brisbane
- Coober Pedy
- Wagga Wagga
- Charleville
- Geelong
- Cairns
- Mt Isa
- Launceston
- Mildura
- Albury
- Canberra

Highly remote	Remote	Outer regional	Inner regional	Major cities

RESEARCH 6.2

In small groups, investigate the challenges and solutions for people living in Coober Pedy, South Australia. You should address the following factors:

- temperature
- rainfall
- geology
- technology
- infrastructure
- tourism.

Debate in class whether or not this is an environment conducive to human settlement.

ISBN 978-1-107-69012-7

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Case study 6.1

Halong Bay's floating village

Halong Bay, Vietnam comprises 4 floating villages, which are home to over 800 inhabitants who have built houses on the water. Fishing is the main source of income for this community and people row from one little house to another, selling their goods or fruits and vegetables that they have obtained elsewhere. The water is very calm because the bay is dotted with large limestone domes that break up any waves, so they don't have to worry about large storm surges. The houses have larger 'outdoor' areas connected by a series of wooden planks tied together; these provide stability for the house as well as a place for a pet dog to run around in, and for the family to fish from. Cap La is a floating village where about 80 families, a total of 200 people, live in this World Heritage Area. In some of the villages, there are television sets and tiled roofs, but in others electricity and freshwater are expensive and difficult to obtain at times. In another village, Cua Van, children row to school. Halong Bay, where daily cruises are offered to Cat Ba Island, is a popular tourist stop in Vietnam.

1 Use a map to locate Halong Bay, Vietnam.
2 List the features of a floating village.
3 Evaluate whether or not this area is conducive to human settlement.
4 Explain why you think Halong Bay is a popular tourist spot.

Source 6.5 Floating houses in Halong bay, Vietnam

ISBN 978-1-107-69012-7

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6.3 Classifying settlements

The settlement hierarchy

settlement hierarchy an ordering of settlements by their size and population. Settlements at the top of the hierarchy, such as large cities, are few in number but hold more status, power and influence. Settlements further down the hierarchy are smaller in size and influence, but greater in number.

One way to classify settlements is by their size. A large population means that a larger area is settled, and more services are both required and provided. There is usually also a large distance between major urban settlements whereas, as we travel down the **settlement hierarchy**, the number of different types of settlements increases but the population and services available decrease. Each settlement varies greatly in nature and character.

Geographical fact

Ekistics is the study of human settlement.

Source 6.6 shows how settlements in Australia can be classified according to population.

Source 6.6 Population of Australia according to the size of settlement, 2001–11

Settlement	Total population 2001[A]	Share of population (%)	Total population 2011	Share of population (%)	Annual average growth 1991–2001 (%)	Projected average annual growth 2001–11 (%)
Big cities (above 1 million)[B]	11 517 061	60.5	13 001 535	61.6	1.2	1.220
Other cities (80 000 to 1 million)	2 600 720	13.7	2 914 838	13.8	1.5	1.147
Large regional/rural[C] (25 000 to 80 000)	1 281 895	6.7	1 348 681	6.4	1.5	0.509
Small regional/rural[C] (10 000 to 25 000)	1 271 603	6.7	1 337 903	6.3	0.6	0.510
Other regional/rural[C] (less than 10 000)	1 825 789	9.6	1 936 494	9.2	0.6	0.590
Remote centres[C] (above 5000)	225 004	1.2	251 048	1.2	0.6	1.101
Other remote[C]	328 779	1.7	328 745	1.6	–0.1	–0.001
Australia[D]	19 297 100	100.00	21 017 300	100.00	1.14	0.858

A Data for 2001 and 2011 are based on ABS projections.

B Includes Sydney, Melbourne, Brisbane, Perth and Adelaide.

C Classification follows Department of Primary Industry and Energy.

D Totals for Australia are based on a different methodology and reference so are not the sum of the above figures. Data for 2001 and 2011 are based on ABS projections.

ISBN 978-1-107-69012-7

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Geographical fact

Over 75% of Australians live in just 17 major cities, according to the 2006 Census.

Centrality and specialisation of settlements

A capital city has a greater **sphere of influence** over all smaller settlements because it usually has more political, economic and cultural power than, for example, surrounding towns. People tend to want to be centrally located. This can be seen in the population distribution in Australia, where approximately 60% of Australians live in state capitals.

sphere of influence an area over which a place has influence; how far people are willing to travel for a particular service

centrality the attractiveness of an urban location in terms of accessibility, functions, facilities and activities

megalopolis a long continuous urban area

The notion of **centrality** has led to the evolution of megalopolises. A **megalopolis** is formed when cities have grown so large that they merge together into 1 massive urban area. This occurs because of the desire for centrality and the importance people place on cities compared to their surrounding regions. The megalopolis in Japan known as the Tokaido Corridor stretches approximately 1200 km and consists of about 80 million people. There are over 10 cities included in this area, which are also linked by the *shinkansen* (bullet train).

From the smallest of isolated dwellings to megacities with over 10 million people, each settlement usually relies on others for various things. Some settlements are established as a result of natural resources, manufacturing or agriculture.

Geographical fact

By 2050, the global distribution of where people live will be more concentrated. Seven out of 10 people will be living in megacities with a population of over 10 million people.

ACTIVITY 6.3

1. Define the term 'settlement hierarchy'.
2. Discuss how the notion of centrality affects where people live.
3. Suggest how a big city's sphere of influence may differ from that of a small town.
4. Explain how a megalopolis forms.

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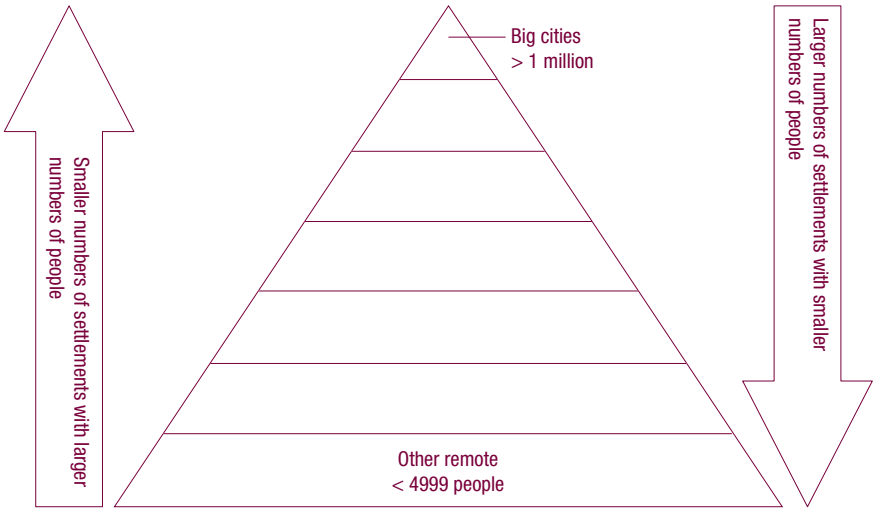
NOTE THIS DOWN

Copy the graphic organiser below and visually depict the settlement hierarchy. Use the data from the Australian Bureau of Statistics.



Settlements by function

functions certain purposes or activities that come naturally to a person or object

liveability conditions in a place that make it easy or difficult to live there

Another way to classify settlements is by their dominant function or main activity. Some cities have evolved over time to specialise in these **functions**. Generally, a mix of all these features is desirable for **liveability**.

Mining

Mining towns have evolved as specialist centres due the location of natural mineral resources. Karratha, Western Australia has developed since the 1960s following the discovery of iron ore and natural gas. It is adjacent to the port of Dampier, so exporting the materials is made easier than it would be if materials were processed and transported elsewhere. It is one of Australia's wealthiest mining towns, and continues to grow.

Source 6.7 An aerial view of Karratha, Western Australia, which is one of Australia's wealthiest mining towns

Tabubil is a small town in Papua New Guinea and was primarily set up as a base from which to operate the BHP-owned Ok Tedi copper mine. It has a diverse population that includes Australians, Canadians, Filipinos and PNG nationals. Even though the town is extremely remote, western culture has infiltrated the region and bakeries, supermarkets, banks and other stores have been established to cater for the international workers. However, it must be noted that, despite the fact that the mine generates wealth, it has caused significant environmental and social problems.

Other towns known for mining are:

- Mount Isa, Qld
- Broken Hill, NSW
- Port Hedland, WA.

Tourism

Some towns are tourist hot spots, specialising in leisure activities for people wanting to go on a holiday. A tourist town may have fun activities on offer, beautiful views, unique wildlife, amazing culture, interesting architecture or significant history. Queenstown, New Zealand is a town primarily based upon tourism, due to the remarkable scenery and adventure activities available there. The population is just over 16000, yet the town receives 1.9 million visitors every year and much of its facilities, employment, infrastructure and buildings cater for the tourism industry. People travel there to ski in winter or participate in different activities in summer, such as jet-boating, bungee-jumping and bushwalking (or tramping, as New Zealanders call it).

Other towns known for tourism include:

- Noosa, Qld
- Daylesford, Vic
- Margaret River, WA
- Katherine, NT.

Source 6.8 Daylesford Lake, located in Victoria's 'Spa Country'. Natural mineral springs, acclaimed cuisine, an historic town centre and country resorts make it a popular spot.

Manufacturing

Some towns have evolved in response to investment in manufacturing. Factories are often built near a good supply of labour but also continue to attract labour, and so the town grows. China is the world's largest producer of cotton textiles (clothes and fabric). Just a few hours' drive north-east of Shanghai is a 'textile-city' so large that 19000 companies operate there. The site was established 20 years ago specifically for manufacturing. One hundred thousand or so customers pass through the city daily, buying goods for distributing to the rest of China and exporting to the rest of the world.

ISBN 978-1-107-69012-7

Cambridge University Press

Geographical fact

The humidicrib (a transparent, plastic box that regulates temperature to help premature babies while they grow stronger) was invented and manufactured in Tasmania by brothers Edward and Don Both in the late 1930s. The invention soon spread across the world and has since helped to save the lives of millions of premature babies.

Agriculture

Some towns can be classified as agricultural towns because most of their income and employment is related to farming activities – cropping, livestock, horticulture or viticulture. Bega, located on the far south coast of NSW, is well known for its dairy farming industry and producing Bega cheese, which is enjoyed around Australia and exported overseas.

Other towns known for agriculture include:

- Tamworth, NSW
- Wubin, WA
- Roma, Qld.

University towns

A university town has a significant student population, and usually includes other organisations such as research institutions and libraries, and businesses targeting university students, such as printing services and bookshops. University life pervades all social and economic activities in the town, so during semester breaks, the town is often quiet and businesses close temporarily due to the lack of **patronage**.

patronage customers paying for goods or services

The highly educated group of people typically engages in activities that challenge traditional norms and trends in music, arts, politics and culture. Examples are:

- Armidale, NSW
- Dunedin, New Zealand.

Administration and government

Canberra, Australia's capital city, was established in 1908 as a specialised settlement for administrative and government purposes in between the 2 major cities at the time, Sydney and Melbourne. In some instances, towns have evolved into administrative centres such as this due to the **specialisation of labour** (e.g. highly skilled professionals live and work in major cities where there is access to employment in international companies) and economic factors.

specialisation of labour labour where the workers spend time in only 1 area of work

Other examples of cities specialising in administration and governance include:

- Brasilia, Brazil
- Beijing, China.

Geographical fact

Many towns in Australia grew due to employment opportunities from manufacturing plants located there. But higher costs and greater efficiency elsewhere has meant manufacturing centres are moving overseas, causing a decline in job availability and ultimately the populations of some towns. Melbourne, Geelong and Adelaide have car-manufacturing plants. Most of the 50 000 people employed in the industry also live in these 3 cities.

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Source 6.9 Brasilia, Brazil, (pictured) is a very planned city with buildings purposely designed for government and administration, just like Canberra.

ACTIVITY 6.4

1. Identify 2 or 3 more towns that specialise in mining, tourism, manufacturing, agriculture, education or administration.
2. Discuss reasons for different towns specialising in different functions.
3. Evaluate the benefits and drawbacks of developing a town such as Tabubil, Papua New Guinea for a specific purpose.

RESEARCH 6.3

Select a town in Australia or Asia to research and report on its function. Present your findings to the class. Your presentation should be no longer than 5 minutes and it must include:

- visual aids such as PowerPoint, Prezi or Keynote
- the location of the town
- reasons why you chose it
- its population
- the features conducive to settlement
- the specialist function of the town.

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6.4 What settlements need

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services and education systems

Every settlement requires adequate infrastructure for efficient functioning and to meet the basic needs of the population. If **infrastructure** is not of an acceptable standard, then issues with the physical, social and emotional health of inhabitants arise. The prevalence of illness is likely to increase if water is contaminated, food is not readily available or of poor quality, housing is unsatisfactory and overcrowded, or there are not enough doctors or adequately equipped hospitals. Towns and cities need all these things for the wellbeing of their people. Healthy populations have a longer life expectancy and tend to be more productive in their activities.

When settlements struggle to provide adequate infrastructure, the level of liveability or quality of life declines. But when settlements are able to provide all these things, they become quite desirable places to live.

Source 6.10 Kabul, Afghanistan, has limited access to clean water. This is one of the reasons people in the city have low life expectancies.

Source 6.11 The Dharavi slum in Mumbai, one of the most densely populated slums in the world, needs adequate infrastructure and services to improve liveability.

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Source 6.12 What settlements need

What do towns and cities need?	Why do they need it?	What's an example of a city struggling with this?
Clean freshwater	Humans need water for drinking, cooking, cleaning, and looking after plants and animals.	In Mumbai, India many pipes are cracked and broken.
Sanitation	Garbage needs to be collected and sewage needs to be **reticulated** and processed.	Some towns in India have open sewers. Rubbish collectors went on strike in Naples, Italy in 2008 and 2010, leaving mounds of rubbish on the streets.
Health	Good doctors' services and vaccinations are needed to eradicate **communicable diseases**.	In Jakarta, Indonesia 80% of groundwater is polluted and carries bacteria such as *Escherichia coli*.
Housing	Humans need some sort of shelter that is stable and large enough to accommodate people comfortably. The types of housing and the number of people living in them vary greatly between cultures.	There is a housing crisis in Tondo, the Philippines, where people cannot afford proper houses and so construct illegal, makeshift dwellings. These slums are home to over 180 000 people, but with assistance from the World Bank and local government, residents were given money and slowly transformed the area, upgrading the slums into a nicer neighbourhood. This took place in the 1970s and was known as the Tondo Foreshore Program.
Food	People need food for sustenance and energy to carry out their daily activities. A range of good quality fresh grains, meat, dairy products, fruit and vegetables is essential for towns and cities.	Food shortages can be caused by natural disasters such as droughts and floods, for example famine in the horn of Africa and in Mogadishu, Somalia.

reticulated sewerage the system of pipes and drains that takes raw sewage from a dwelling to a sewage treatment plant, removing the need for open channels that smell and are unhygienic

communicable diseases infections and diseases that can be transmitted from one person to another

Geographical fact

The Millennium Development Goals aim to improve the provision of freshwater, sanitation, health, food and other services to the global population. Goal 1 – ending poverty and hunger – is one of the most achievable. However, as a result of the global economic crisis (2007–12) the World Bank predicted that 53 million more people will remain in extreme poverty by 2015 than otherwise would have.

ISBN 978-1-107-69012-7

ACTIVITY 6.5

1 Define the term 'infrastructure'.
2 Examine why settlements need sanitation services.
3 Summarise what the Philippines did to address deficiencies in housing.
4 Justify the following statement: 'Cities need all services and infrastructure to function effectively, not just some'.

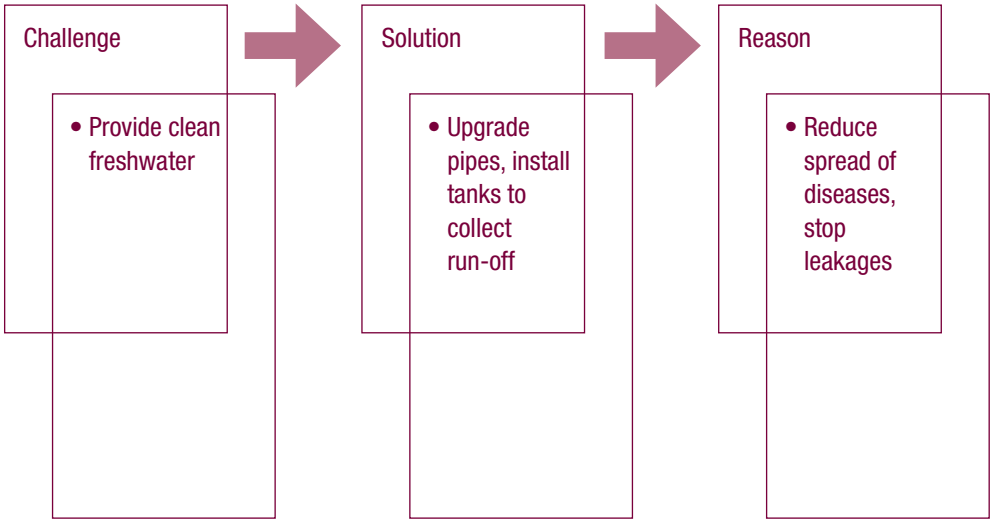
RESEARCH 6.4

Some cities experience many challenges in making sure their population has adequate access to infrastructure. Imagine you are a person living in 1 of the cities below and write a diary entry about both the challenges and solutions faced.

- Manila, the Philippines
- Mumbai, India
- Mexico City, Mexico
- Lagos, Nigeria
- Jakarta, Indonesia
- Bangkok, Thailand.

NOTE THIS DOWN

Copy the graphic organiser below and summarise the difficulties, pose solutions and justify reasons for actions in megacities facing challenges associated with socially valued resources such as water, health, sanitation, housing and food.



ISBN 978-1-107-69012-7

FIELDWORK 6.1 SURVEYING THE LIVEABILITY OF YOUR AREA

Aim

To determine the liveability of different places and compare the liveability of each.

Method

A survey can consist of questionnaires, interviews and observations. To determine the liveability of the place where you live and to provide a balanced viewpoint, you need to use all 3 primary methodologies. Select 2 or 3 sites or suburbs to examine liveability.

Data collection

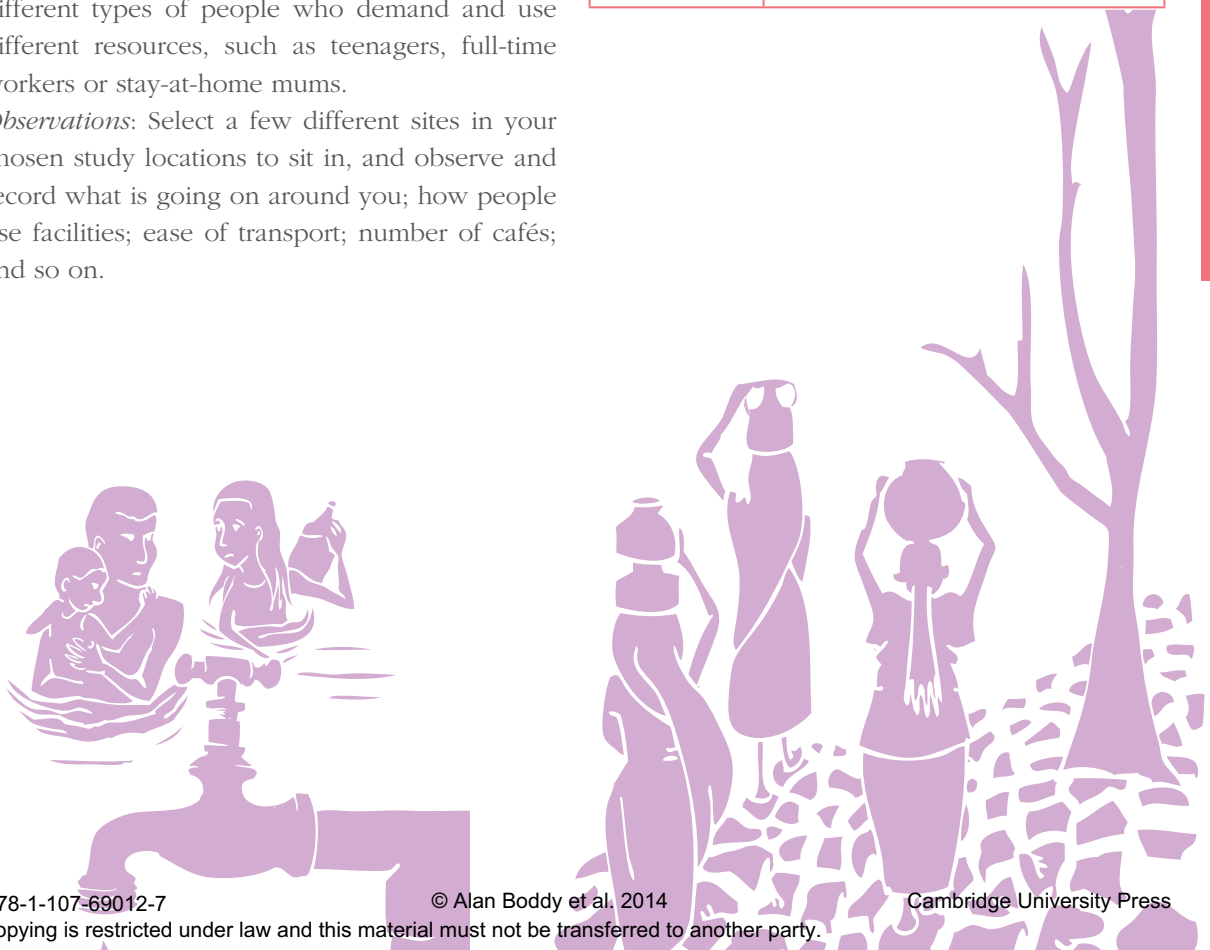
Questionnaire: You will need to construct a questionnaire to find out what people think of your chosen areas. You can do this easily online using Survey Monkey or Zoomerang. When finished, you may email the questionnaire link to family and friends in your area. Try closed-ended (yes/no) questions, as these are easier to collate and derive statistics from.

Interview: Think about who you would like to interview about the liveability of your area. For example, you may get different opinions from an elderly resident who has lived there for many years, a new resident who just moved in, or even different types of people who demand and use different resources, such as teenagers, full-time workers or stay-at-home mums.

Observations: Select a few different sites in your chosen study locations to sit in, and observe and record what is going on around you; how people use facilities; ease of transport; number of cafés; and so on.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location maps
Page 3	Introduction – brief description of the study sites and photos
Pages 4 and 5	Site 1 survey results
Pages 6 and 7	Site 2 survey results
Pages 8 and 9	Site 3 survey results
Page 10	Discussion about liveability, strengths and weaknesses of each site
Page 11	Conclusion about the highest level of liveability
Page 12	Appendix, bibliography, glossary



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Chapter summary

- A community is a group of people that share a similar interest.
- Factors that influence people's choice of settlement include environmental constraints, land availability, affordability, proximity to relatives, job location and connection to a place.
- Environmental factors that influence where people live can include climate (temperature, wind and rainfall) and topography (geology and gradient).
- Perceptions of remoteness vary between communities; this influences where people are prepared to live and travel.
- Settlements can be classified according to their size; this creates what is known as the settlement hierarchy.
- Settlements can also be classified according to their main function. Often, they have evolved to specialise in functions such as mining, tourism, agriculture, manufacturing, administration or education, due to the resources available there.
- Cities require adequate infrastructure to function effectively, such as clean freshwater, sanitation, health services, housing and food. Some cities really struggle to provide these.

End-of-chapter questions

Multiple choice

1 Which of the following is not a reason for influencing people's choice of settlement location?

A Affordability
B Accessibility
C Profitability
D Liveability

2 Which US city overcame environmental constraints of water supply by using recycled water?

A New York
B Phoenix
C Los Angeles
D Atlanta

3 What proportion of the Australian population lives in big cities?

A 30%
B 40%
C 50%
D 60%

4 For which function is the town of Bega, NSW best known?

A Agriculture
B Manufacturing
C Tourism
D Mining

5 What 3 cities were built specifically for the purposes of administration and government?

A Dublin, Cape Town and Hanoi
B Auckland, Adelaide and New York
C Brasilia, Beijing and Canberra
D Delhi, Singapore City and Dubai

ISBN 978-1-107-69012-7

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Short answer

1 Analyse the environmental factors that influence where people choose to live.

2 Articulate 'centrality' and explain how it affects where people live.

3 Summarise the settlement hierarchy.

4 Critically analyse whether a mix of functions in a settlement is crucial for liveability. In your response you must refer to functions such as mining, tourism, manufacturing, agriculture, administration, government and education.

5 Investigate how and why some cities struggle to provide basic services. Use examples in your answer.

Extended response

Discuss to what extent mining towns and tourist towns are the only settlements that can be created specifically for those purposes. In your response you must:

- refer to specialist towns and their main functions
- find out if the towns evolved into those functions or were created specifically
- use a range of examples
- make a judgement; have an opinion in reference to the question.

Source 6.13 Singapore is the most densely populated country in the world, with roughly 7300 people per square kilometre.

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Source 6.14 Queenstown in New Zealand has tourism as its primary industry. Adventure tourism has been developed out of the tourism generated by the natural beauty of the area.

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7 Housing

Source 7.1 Variety of housing in Manila, the Philippines

ISBN 978-1-107-69012-7

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Before you start

Main focus

Housing density influences the liveability of cities in Australia and Europe.

Why it's relevant to us

The built environment, particularly housing, has a huge influence on people and the way that they interact with their community.

Inquiry questions

- What are the different types of housing?
- What are the 3 main types of housing density?
- What are the advantages and disadvantages of different types of housing density?

Key terms

- High-density housing
- Low-density housing
- Medium-density housing
- Transport modes
- Urban consolidation
- Urban sprawl

Let's begin

Housing is a basic necessity for life – we all need somewhere to live. But there are many different styles of housing, each with its own advantages and disadvantages, and every style was created to meet the needs of the local environment. In turn, housing styles also influence the environment, such as affecting roads, water supply systems and transportation. There are particular styles that are popular in Australia and Europe, and the kinds of houses you find in the bush are very different from those you find in cities like Sydney.

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7.1 Types of housing

Housing in Australia

Australia has a number of different types of housing; that is, different sorts of dwellings. These dwellings come in a number of different forms, but the most common in Australia are houses; flats, units or apartments; terraces; and townhouses. Each housing type is a reflection of the history and location of the dwelling. According to the Australian Bureau of Statistics (ABS), the most common housing type in Australia in 2009–10 was separate housing (79% of the population), with 11% living in flats, units or apartments, and 10% living in **semi-detached houses**, **terraces** or townhouses.

semi-detached houses two houses that are joined by a shared wall

terraces rows of houses that share their sidewalls with the adjacent houses

Housing in Europe

Compared to Australia, Europe has a very different composition of housing. According to the European Commission, 42% of the European population live in flats or apartments, with 34% living in separate housing and 23% in semi-detached housing.

Comparing Australia and Europe

There are a number of factors that account for the difference between housing in Australia and housing in Europe:

- *Availability of land.* Australia has larger areas of available land, which facilitates the building of separate houses. Europe has less land area, so cities maximise their land use by having more flats or apartments.
- *Climate.* Australia has a much warmer climate than Europe, and primarily separate housing allows for better cooling throughout the hot weather conditions.
- *Population density.* Europe has a greater population than Australia and a smaller land area, and so Europe has a higher population density. This has led to greater use of housing designed to cater for higher densities, such as flats or apartments.
- *Historical and cultural aspects.* Large sections of housing in Europe, especially in the cities, were designed a long time ago – hundreds or even thousands of years ago. This has greatly influenced the types of housing that have developed.

Source 7.2 Town square in the Alsatian city of Colmar, France

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Geographical fact

Europe's population was estimated to be 739 million in 2011.
Australia's population was 22.6 million in 2011.

ACTIVITY 7.1

Conduct a class survey on housing.

1. Construct a table using the 3 types of houses (1 Separate house; 2 Unit, flat or apartment; 3 Semi-detached, terrace or townhouse)
2. Identify which type of house you reside in and mark it in the table.
3. Compare your experience with the rest of your class.
4. Collate the class results and use the data to construct a column graph.
5. Compare your class results with the ABS data on Australia. Do your class results match the ABS data? If not, why do they differ?
6. Compare your class results with the European Commission data on Europe. Why do you think your results are different from the European data?

NOTE THIS DOWN

Copy the table below and compare the 3 different types of housing. In the first column, write down 1 or 2 positive things (pluses) about each type. In the second column, write down 1 or 2 negative things (minuses) about each type. In the third column, write down 1 thing you find interesting about each type.

Types of housing	Plus	Minus	Interesting
Separate house			
Unit, flat or apartment			
Semi-detached house, terrace or townhouse			

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Residential areas

Residential areas have shaped and transformed global cities throughout time. Residential areas have dictated the growth of a number of cities around the world. To identify how residential areas have influenced the development of cities, we need to understand the 3 key residential areas that exist within cities:

1 *low density:* single or double level housing, usually situated on 1 site. The residence usually has some green space associated with it.

Source 7.3 Low-density housing in Sydney

2 *medium density:* housing that has a density of around 3 to 10 storeys in elevation.

Source 7.4 Medium-density housing in Istanbul, Turkey

3 *high density:* housing that has a density of 11 or more storeys within buildings. This is primarily associated with inner-city areas.

Source 7.5 High-density housing in Brisbane

ISBN 978-1-107-69012-7

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Case study 7.1
Sydney

Sydney is Australia's largest city, with 4.6 million people. Sydney was established as a British colony on 26 January 1788, and has grown over time to become a global city with a significant role in the Asia–Pacific region.

Sydney's size has increased to over 12 000 square kilometres, and most of this residential growth has occurred in low-density housing. Around 60% of Sydney's housing is low-density, and this has resulted in the urban area sprawling outwards from the city. Source 7.6 illustrates how the housing density of Sydney decreases as you move west from the City CBD. Areas such as Blacktown, Rouse Hill, Mt Druitt and Leppington are examples of Sydney suburbs that are dominated by low-density housing.

Source 7.6 Decrease in housing density moving away from the CBD of Sydney

According to the New South Wales government's Department of Planning, Sydney's population is likely to grow by 40% by the year 2036. This is going to require an additional 770 000 homes over the same period – a 46% increase on the current 1.68 million homes. To accommodate this growth, the government cannot rely on low-density housing, and is encouraging the building of medium- and high-density residential housing. Suburbs have been developed with this specific focus in mind, and include Chatswood, Bondi Junction, Rhodes, Pyrmont and Meadowbank.

1. Explain why Sydney has so much low-density housing and why the urban area expanded outwards.
2. Suggest 2 reasons why Sydney requires a 46% increase in housing for only a 40% increase in population.
3. Investigate the projected population growth for your own town or city (or another you know) and compare it to what is expected for Sydney by 2036. Explain why it is similar or different.

Source 7.7 Medium-density housing in the Sydney suburb of Rhodes

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7.2 Urban sprawl

urban sprawl growth of housing on the edge of a city

Urban sprawl is the spreading of the urban area of a city into the surrounding rural or semi-rural areas. It has been the main philosophy that urban planners have used to develop cities, especially in Australia and the United States. It involves the spreading of low-density housing away from the central areas of a city. As a result, the city's urban area slowly moves out into the surrounding rural areas, taking up huge areas of land.

A number of concerns are raised about the use of urban sprawl as a method of providing housing:

- The destruction of natural habitat and loss of biodiversity. Spreading out the urban development consumes vast areas of land, which then results in the destruction of the natural environment. Additionally, as cities consume more and more land, they affect the natural function of the environment, which in turn affects the **biodiversity** in the area – for example, destroying animal and plant species.

biodiversity the number and variety of species of plant and animal life within a region

- New infrastructure. With the arrival of new housing developments on the urban periphery comes a constant need for infrastructure to be developed. This infrastructure includes roads, sewerage, rail and bus links, hospitals, schools and educational facilities.
- Low population density. Allowing urban sprawl to occur creates a lower population density. This is a waste of a very valuable resource, which could be better used by building higher-density housing over the same land area.
- Provision of public transport. With urban sprawl constantly pushing the edge of cities outwards, it becomes very hard for governments to keep up with the ever-increasing demand for public transportation.

ACTIVITY 7.2

Imagine that a new low-density housing development is going to be built on the edge of your city or town.

1. Propose any possible environmental effects or loss of biodiversity the development could cause in the area.
2. Recommend any infrastructure needs the new development would have. Could these be met by the town or city's existing infrastructure, or would new facilities need to be built?
3. Identify the development's public transport needs and suggest a new form of public transport that could be effective for the inhabitants.

In contrast to this, the use of medium- and high-density housing has become an increasingly effective way to reduce the problems that are created by urban sprawl. This is sometimes called **urban consolidation**. Medium- and high-density housing is a more efficient way of using the land. It allows for more people to be housed in an area, which allows for a greater population density. It also makes better use of the current infrastructure (roads, railways, sewerage etc.), therefore saving the government money by not having to create new infrastructure on the edges of the city.

urban consolidation building up existing urban areas rather than moving people to the edges of the city

One of the best examples of medium-density housing is seen in the city of Paris. In the mid-1800s, Napoleon III decided that he wanted to revitalise Paris. He employed **civic planner** Georges Haussmann to redesign the housing, streets and streetscape in the centre of the city to improve the flow of traffic and quality of housing provided. Haussmann

civic planner someone who plans the layout, development and growth of cities and urban areas

ISBN 978-1-107-69012-7

achieved this by creating a uniform height for the residential buildings in central Paris. The buildings were designed to allow for both commercial and residential use, with the bottom floor designated as the retail area (e.g. shops and cafés). The floors above were then used as residential areas.

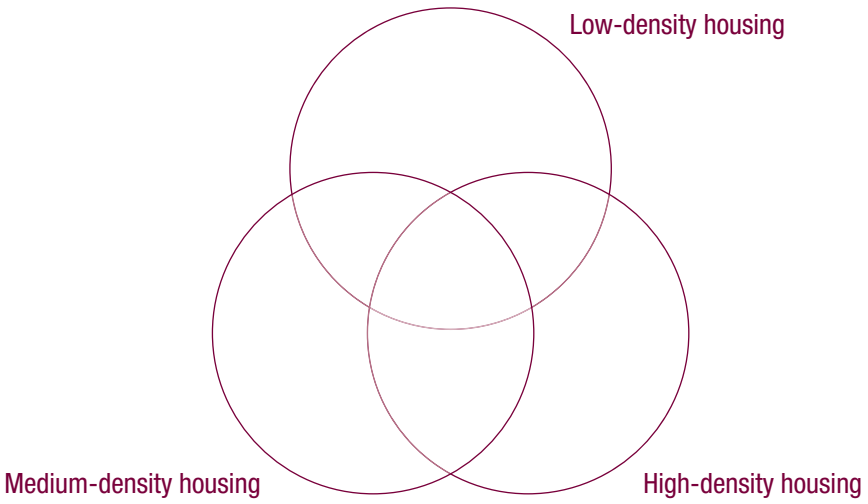
Despite the obvious benefits, there are some arguments against a medium- or high-density approach:

- An increase in population density also increases the amount of waste products produced (e.g. rubbish).
- It increases the amount of noise and congestion in established suburbs (e.g. increased traffic).
- It creates a greater demand for services to cater for the increased populations (e.g. shops and doctors).

Source 7.8 Medium-density housing in Paris

NOTE THIS DOWN

Copy the graphic organiser and compare low-, medium- and high-density housing. In the main part of each circle, list some unique features that only that kind of housing has. Where the circles overlap, list at least 1 feature that the types of housing have in common.



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ACTIVITY 7.3

Imagine that a new, 15-storey block of high-density apartments is going to be built in the centre of your city or town.

1. Calculate how many people would live in the block if every apartment was occupied.
2. Suggest 3 positive effects that the new block might have on the inner-city area and community.
3. Suggest 3 negative effects that the new block might have on the inner-city area and community.

7.3 Transportation modes

The types of housing densities that exist within cities influence the type of transportation that is available in those areas. Each housing density (low, medium and high) has its own specific needs and requirements. As the housing density increases, so does the population density; this creates a number of issues with regard to transportation. The greater the population in an area, the better the transportation system needs to be to move larger volumes of people.

A good example of this is London, the capital city of England. London has a population of 8.1 million people who live primarily in medium-density housing. A number of transport modes are available to the people of London – the main types are trains, buses and cars. The most used of these is the above-ground and underground rail system called 'the Tube'. The underground railway was first run in 1863, and has been known as the Tube since 1890. There is now an extensive network of railway lines that stretches for 402 km around London. This railway system carried 1.171 billion passengers in 2011–12, 64 million passengers more than in the previous year. During the 3-hour morning peak period, Waterloo (London's busiest station) has 57 000 passengers enter the station. This shows

Source 7.9 The Oxford Circus Tube station, London

ISBN 978-1-107-69012-7

Source 7.10 Housing in London, viewed from Westminster Cathedral

Source 7.11 An aerial view of Waterloo Station, London's busiest station

how a city that is dominated by medium housing density has to have a transport mode that is able to cope with large volumes of people.

By contrast, a city with a low density of housing has very different modes of transport. Dubbo is a city of around 41 000 in the central west of New South Wales. Dubbo's housing is dominated by separate, detached houses; these account for 83% of all housing in the city. This clearly puts Dubbo into the low-density housing category. Due to the dominance of low-density housing, Dubbo's urban area has sprawled out over a larger area, requiring people to travel increased distances to get around the city. This in turn has led to a heavy reliance on motor vehicles as the main form of transport. According to the 2011 Census data, 38% of people in Dubbo owned 1 car and 49% owned 2 or 3 cars. This means that 87% of people in Dubbo own at least 1 car, making it the most common mode of transport. There are some other factors that contribute to this, such as the lack of other forms of public transport. There are buses that run around Dubbo, but they are not as frequent as they would be in larger cities. This causes people to look for a more frequent and reliable mode of transport, such as cars.

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Source 7.12 A typical house type in Dubbo, New South Wales, with a two-car garage

RESEARCH 7.1

Use the Australian Bureau of Statistics website to conduct research into your local area. Select your local suburb or the town that you live in. Locate the following data:

- dwelling types
- car ownership
- public transport facilities.

Compare the data you obtain with those of Dubbo, and explain the reasons for the differences or similarities. Present your findings in a PowerPoint presentation.

Public transport

public transport a form of transport that can be used by any member of the public, whether free of charge or for a fee

An advantage of medium- to high-density housing is that it provides greater opportunity to use **public transport**. Because this type of housing has a higher population density, there is more opportunity for people to avail themselves of public transport.

Public transport in cities primarily consists of buses, trains, light rail and ferries. For example, Source 7.13 shows a Melbourne tram; it provides a transportation link into the city's Central Business

Source 7.13 Trams in the city of Melbourne

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District. In Brisbane, the City Cat ferry service (Source 7.14) provides an important transport link between suburbs to the city. London has the most well-known buses in the world. The red double-decker buses (Source 7.15) are an iconic part of London, but they also play an integral role in the city's public transport system, with thousands of people transported daily around the city.

Source 7.14 City Cat ferry in the city of Brisbane

Source 7.15 The red double-decker buses of London

RESEARCH 7.2

Select 2 different towns or cities and investigate the types of public transport available. Work through the following points and present your findings in an oral presentation to the class.

- List the types of public transport that are available in the local town or city.
- What type of public transport is most popular in the area? Suggest 2 reasons why it is the most popular.
- Are there any common types of public transport that are not available in the area? List them and suggest reasons why they are not suitable or available in the town or city.

ISBN 978-1-107-69012-7

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7.4 Different styles of housing

Another advantage of medium- to high-density housing is the increased development of services to cater for the needs of the population. Higher populations make a range of various services – such as restaurants, cafés, bars, theatres, cinemas and supermarkets – more important and more likely to be financially successful.

To gain an understanding of the advantage and disadvantages of this style of housing, let's look at a case study of the suburb of Pyrmont in Sydney.

Case study 7.2
Pyrmont, Sydney, New South Wales

peninsula a piece of land going out into water from a larger land mass

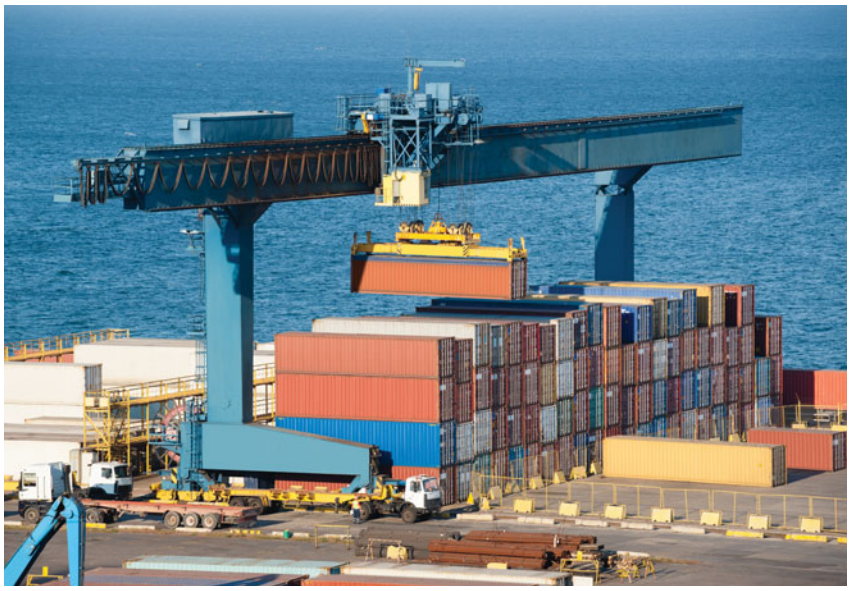
Pyrmont is a 1.6 km^2 **peninsula** next to the Sydney CBD. It has gone through a dramatic transformation in the last 30 years, from a major industrial area and port facility to a high-density residential, commercial and recreational area. The redevelopment of the Pyrmont area is one of the most significant urban renewal programs undertaken in Australia. Pyrmont–Ultimo is one of the fastest growing areas of Sydney, with its population expected to rise to over 20 000 by 2012. In 1994, fewer than 5000 people lived in the area, but Pyrmont–Ultimo's population has increased as more facilties and services have been provided.

History

Pyrmont's history has seen many and varied uses for the small peninsula. During the time of Indigenous Australians, Pyrmont was used as a location for hunting fish and gathering food, such as cockles. After 1788 and European occupation, the site of Pyrmont was owned by a number of individuals, who built sandstone quarries and port facilities. The rapid development of Pyrmont really began in 1902 when a bridge was built between Pyrmont and the Sydney CBD.

During the early 1900s, Pyrmont saw a rapid growth of industrial activity. The suburb became the major port for Sydney, and a large number of other services sprang up around it, such as railway goods yards, wool stores and large **wharfs** to accommodate the ships. There were also 2 major industrial businesse located in Pyrmont – a power station and a CSR sugar refinery. The sugar refinery was the largest factory in Pyrmont and

wharf a human-made landing place for ships on a shore



Source 7.16 Modern port facilities at Port Botany

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Source 7.17 Jackson's Landing site today; it was once the CSR sugar refinery.

covered the whole north-west section of the peninsula.

During the 1970s and 1980s, Pyrmont started to fall into urban decay. One reason for this was the relocation of the port facilities to a modern site at Port Botany. Other reasons included the **decentralisation** of industry, the closure of the power station and the relocation of the sugar refinery to Queensland. As a result of this, the population fell dramatically; in the late 1980s it was only about 900 people. The built environment fell into disrepair, with houses and factories left to decay.

decentralisation the process by which population and industry move from an urban centre to outlying districts

In 1992, the New South Wales government initiated a major urban renewal program for Pyrmont, funded in part by a $241 million grant from the federal government's 'Building Better Cities' program. The aim of this program was to revitalise the suburb into a modern mix of residential, commerical, retail and recreational areas.

Socio-cultural and environmental advantages

As part of the urban renewal process, a number of significant changes were made to the housing in Pyrmont. During the suburb's industrial period, the houses primarily consisted of small stone workers' cottages. During the renewal process, the new housing was instead designed as high-density housing. There are a number of **socio-cultural** and **environmental** advantages to this:

- Providing a range of high-density housing is a good way to maximise the use of the restricted land available.
- Utilising high-density housing freed up large areas of land that have been designated as **green space**, such as Pirrama Park. This provides valuable recreational areas for residents and vistors, as well as improving the appearance of the suburb.
- A range of services to cater for the residents (e.g. cafés, resturants, bars and supermarkets) has been developed; these are more commercially viable.
- Transport infrastructure has been developed to cater for the increased population (light rail, cycleways and walkways).
- The high-density housing, combined with the proximity to the Sydney CBD and the development of services, has catered for the young professional demographic, who are the dominant age group that now live in Pyrmont (36% of the population is aged 25–34 years).

socio-cultural relating to both society and culture

environmental relating to the physical environment

green space an area of grass, trees or other vegetation set apart for recreational purposes in an urban environment

ISBN 978-1-107-69012-7

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- The development of medium-sized businesses in the area (particularly technology and entertainment businesses) allows people to be employed and live close to where they work. These businesses include Channel Seven, Channel Ten, Fox Sports, Google, Nokia, the Star Entertainment Complex and Nova radio station.

Socio-cultural and environmental disadvantages

As well as all the advantages, there are some negative aspects to the development of Pyrmont:

- The area is increasingly dominated by 1 **demographic** (young professional people) and is therefore not a real reflection of society as whole. People living in Pyrmont may not have easy access to their extended families, and the community lacks variety and richness.

demographic a group of people defined by a particular shared characteristic

- The domination of high-density housing creates environmental issues because it increases the production of waste products in a small area.
- Rents and housing costs in Pyrmont are higher than in other regions, making it difficult for many people to consider living there.

1 Suggest 1 reason why the port facilities might have been moved from Pyrmont to Port Botany.

2 Why do you think the Australian government established a 'Building Better Cities' program? Investigate the history of the program and name 2 other regions that have benefited from it in the past.

3 Compare the changes in Pyrmont from colonisation to the modern day to the history of growth and change in your own town or suburb, or another town or suburb you know. Are they similar or different? Suggest 3 reasons why your suburb or another suburb changed in different ways from Pyrmont.

Source 7.18 The Star Entertainment Complex

Source 7.19 Pirrama Park provides valuable green space to a high-density suburb.

Source 7.20 Young professionals dominate housing and employment in Pyrmont.

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ACTIVITY 7.4

Using Google Earth and Google Maps, conduct a virtual field trip around the suburb of Pyrmont.

1 Open Google Earth.

2 Search for the following locations:

- **a** 29 Pyrmont St
- **b** 115 Harris St
- **c** the corner of Jones St and John St (looking north-west).

Type the address into the search box. Remember to use the Street View mode (drag the yellow person onto the location).

3 Describe what types of built features are located in each of the locations. Is it mostly commercial/residential or a mix of the 2? Are the buildings high, low or medium density? What infrastructure and services are in place around the locations?

NOTE THIS DOWN

Copy the table below and conduct a SWOT analysis of high-density housing areas such as Pyrmont. Write down 3 strengths of this kind of area, then 3 weaknesses of the area. Once you have done this, write down 3 opportunities that become possible in a high-density area, and then 3 threats that might become a problem for such an area.

High-density housing developments	
Strengths	**Weaknesses**
• • •	• • •
Opportunities	**Threats**
• • •	• • •

Geographical fact

The Census of Population and Housing is conducted every 5 years and is the largest statistical collection undertaken by the Australian Bureau of Statistics (ABS). The aim is to measure the number of people and dwellings in Australia on Census Night. The next Census is scheduled for August 2016.

ISBN 978-1-107-69012-7

Cambridge University Press

Chapter summary

- The most common housing type in Australia is separate housing (79% of the population), followed by flats, units or apartments (11%) and semi-detached houses, terraces or townhouses (10%).
- In Europe, 42% of the population live in flats or apartments, with 34% living in separate housing and 23% in semi-detached housing.
- There are 3 main types of housing densities in cities: low, medium and high.
- The type and size of a city dictates the main transportation modes that are used in that city.
- There is a range of unique transportation modes that exist in a range of cities around the world.
- There are several advantages and disadvantages to all housing types.

End-of-chapter questions

Multiple choice

1 Which is Australia's most common housing type?

A Flat, unit or apartment
B Townhouse
C Separate house
D Semi-detached house

2 Which is Europe's most common housing type?

A Flat/apartment
B Townhouse
C Separate house
D Semi-detached house

3 What are the main types of housing densities in cities?

A Low
B Medium
C High
D All of the above

4 What is the name of London's busiest railway station?

A King's Cross
B Waterloo
C Westminster
D Gloucester Road

5 Pyrmont was once a:

A heavy industrial area
B wealthy residential area
C recreation area
D business area

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Short answer

1 Explain the difference between the 3 types of housing. Identify 1 advantage and 1 disadvantage for each type.

2 Compare and contrast the housing in Australia and Europe.

3 Critically analyse this statement: 'High-density housing is better overall than urban sprawl.'

4 How does the transportation change as a result of the type of housing in a city?

5 Has the redevelopment of Pyrmont been successful? Explain why or why not.

Extended response

Write a report assessing the types of housing located in your local town, suburb or area. In your report, identify the types of houses as:

- low density
- medium density
- high density.

Conclude your report by explaining some of the effects the different kinds of housing have on your local area and on your community.

Source 7.21 Houses in Amsterdam, the Netherlands

ISBN 978-1-107-69012-7

Cambridge University Press

8 Demography and living choices

Source 8.1 A south Florida suburban housing community

ISBN 978-1-107-69012-7

Cambridge University Press

Before you start

Main focus

Demographic characteristics and trends have many influences on the character of a place and there are a number of factors which influence the choices we make about where we would like to live.

Why it's relevant to us

Studying these characteristics and choices will allow you to gain a deeper knowledge of places.

Inquiry questions

- What is the demography of places?
- How does demography influence the character of a place?
- Why do people live where they do?

Key terms

- Age
- Choice
- Demographics
- Economic
- Enclave
- Environmental
- Ethnicity
- Factors
- Historical
- Infrastructure
- Political
- Settlement
- Social
- Technological

Let's begin

Demographic characteristics and the choices we make about where to live shape and transform places. Demographic characteristics are factors like income, gender, age and level of education. We can gather these statistics with tools like the Census. Analysing demographics lets us interpret key trends that occur and their influence on the nature of places. The choice of settlement is very personal and there are factors that influence this decision within our control, but there may be other factors over which we have very little control at all. For example, we may like the idea of living near a surf beach, but our work may be in a major city, well away from the coast.

ISBN 978-1-107-69012-7

8.1 Demographic characteristics

Demographic characteristics – or just 'demographics' – are features common to the people that make up a population. These include:

ethnicity a person's racial or cultural background

- age
- gender
- **ethnicity**
- religious affiliation
- income level
- employment
- level of education
- dwelling structure (types of dwelling).

The Census

Demographics are generally things that can be counted and collated through some kind of statistical process, like a survey. The Australian government conducts a census every 5 years to gather demographic information; the last one was in 2011. Most demographics are put into groups or bands, rather than counting every possible answer. For instance, instead of listing every possible income people might make, we group answers into ranges like $40 000–$50 000.

Source 8.2 Age and gender are two key demographic characteristics.

Source 8.3 Income and occupation are key demographic characteristics.

Geographical fact

In the 2006 Census over 55 000 Australians declared themselves as members of the Jedi order. This was viewed as a joke and labelling oneself as Jedi in the 2011 census meant your religion was not acknowledged. 'Pastafarianism' is also not acknowledged as a religion by the Census!

ISBN 978-1-107-69012-7

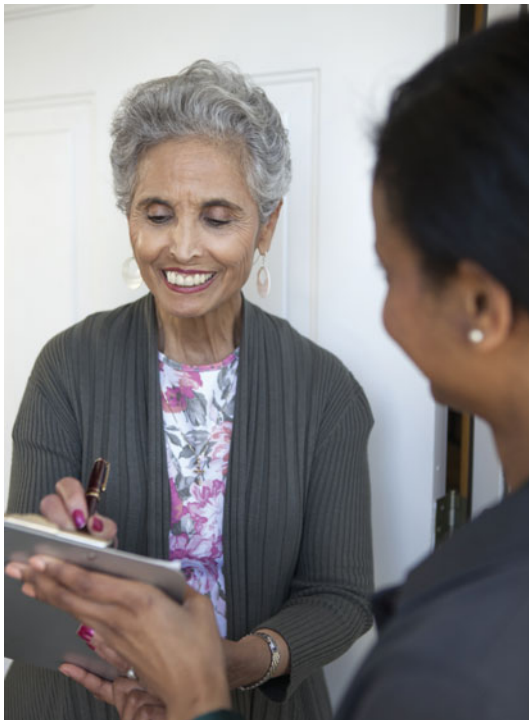
RESEARCH 8.1

Use the Australian Bureau of Statistics website to create a demographic profile of your local area. Go to the following link for guidance on finding the data on the Australian Bureau of Statistics site, and follow the instructions to create your demographic profile: www.cambridge.edu.au/geography7weblinks.

Use the following headings to collect information on your local area:

- average age
- gender
- ancestry
- religious affiliation
- occupation
- average weekly income
- family composition
- dwelling structure
- number of motor vehicles.

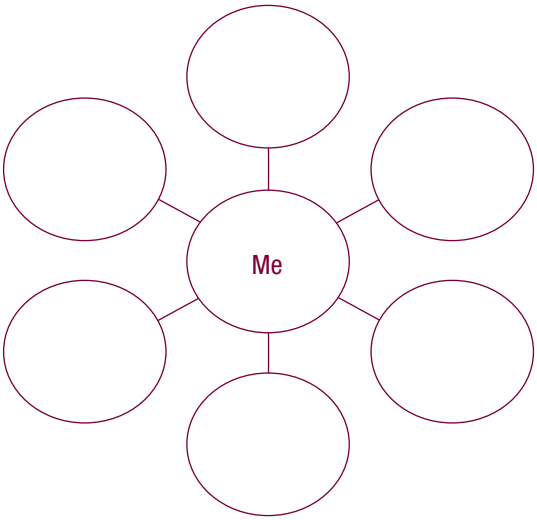
Collate all your information in a table. Then write a summary of all the statistics into a community profile of your local suburb or town. Are there any noticeable trends that stick out, such as a high proportion of people of a particular religious persuasion? Are more people on high weekly incomes than on low ones? Use the data to characterise your area.



Source 8.4 The Australian Bureau of Statistics Census finds out a lot of information about people all over Australia.

NOTE THIS DOWN

Copy the graphic organiser and suggest some demographics that are especially relevant to you and your life. They may be things that apply to you, your friends or your family.



ISBN 978-1-107-69012-7

Cambridge University Press

ACTIVITY 8.1

Conduct a survey to gather data on the demographics of your Geography class.

As a group, design a survey for the class. It should survey 3 demographics that relate to students, not just their families or parents. Here are some possibilities:

- height (broken into bands)
- how you get to school
- favourite subject
- kind of house you live in
- favourite sport.

Every student should answer a survey. As a class, collect all the surveys and then collate all the answers.

If possible, compare the results to those of another Geography class at your school. Are they different or similar? Why do you think that is?

8.2 Demographic profiles

demographic profile a collection of demographic information used to create a description of an average member of the population

The **demographic profile** of a suburb, town or city can have a dramatic influence on the nature of a place. There are a number of characteristics that have an influence on the nature of places within Australia.

Income

The most influential of these would be income; a higher average income in a location generally indicates that the area is wealthier. A higher average income indicates that house prices are high and that predominantly wealthy people and families can afford to live there.

Source 8.5 shows the 2 wealthiest locations in each state and territory of Australia – the towns or suburbs where the average income is the highest. This information is collected and analysed by the Australian Taxation Office.

These figures illustrate the division that exists between income levels and the state that people live in. This in turn influences the nature of the place and who lives there. For example, people seeking higher incomes are more likely to move to a wealthy city like Sydney or Melbourne, where the potential for a bigger salary is greater. They may also look at the wealthier regional areas in Queensland and Western Australia, where the mining and resources boom has resulted in increased salaries – and increased costs of living.

People's demographic income status also dictates the locations in which they can choose to live. The higher your income, the more choice you will have in selecting where you live. This shows how the demographic of income influences the nature of place in regard to housing.

ISBN 978-1-107-69012-7

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Source 8.5 Wealthiest locations in Australia

State	Locations	Average income
Victoria	Toorak	$132 252
	Brighton	$101 776
New South Wales	Double Bay	$129 116
	Mosman	$126 956
Western Australia	Cottesloe	$113 892
	Nedlands	$106 981
Queensland	Ascot	$90 945
	Hamilton	$90 900
Australian Capital Territory	Red Hill	$87 496
	Forrest	$87 488
South Australia	North Adelaide	$75 574
	Walkerville	$74 296
Northern Territory	Anindilyakwa	$73 480
	Nhulunbuy	$63 985
Tasmania	Taroona	$50 977
	Mount Nelson	$50 941

Source 8.6 Mosman has one of the highest annual incomes in Australia. It is attractive to the wealthy due to its location on Sydney Harbour and its proximity to Sydney's CBD.

Source 8.7 Cottesloe has Western Australia's highest annual income. It is desirable because of its location on the Indian Ocean.

ISBN 978-1-107-69012-7

Cambridge University Press

ACTIVITY 8.2

1. Go back to the ABS website and look up the Census page for the area where you live. Click on the 'People' bar and read down this section.
2. The page lists personal, family and household incomes. Explain what these 3 figures are and suggest a reason why they are all different (if they are).
3. Explain what the 'median' is and how it differs from other measures of centre like the mean and mode.
4. Suggest a reason why the ABS uses the median income figure instead of another measure of centre.
5. Suggest a reason why other demographics like 'Average motor vehicles per dwelling' don't use the median.

Age

Age is another demographic that influences the nature of places in Australia. You will most likely live in different places at different stages of life. Your age, and whether you are employed, retired or gaining your education, will influence where you live, which in turn influences the development and structures of towns and cities.

According to the Australian Bureau of Statistics Census 2011 data, the locations in each state that have the highest average age are mainly centred around the coast.

Source 8.8 Locations with the highest average age

State	Locations	Average age (years)
Victoria	Paynesville	56
New South Wales	Tuncurry	59
Western Australia	Mandurah	49
Queensland	Bribie Island	57
South Australia	Victor Harbor	56
Tasmania	Triabunna	53
Northern Territory	Ross	42
Australian Capital Territory	Isaacs	47

These data show that once people reach retirement age, they tend to move or relocate to coastal towns. They do this because they want to enjoy their retirement and make the most of the coastal lifestyle (with its strong sense of community and recreation activities). As a result of the movement of aged people towards the coast, state governments have to make sure that there are adequate services for these areas, such as health services, hospitals and aged care facilities.

As well as the elderly, the number of people aged under 15 years will affect a location's nature. Most people in this age bracket are at educational institutions such as schools, preschools or early childhood centres. As such, they have unique needs and demands for services within their areas.

ISBN 978-1-107-69012-7

Cambridge University Press

Source 8.9 The Wallis Lakes area, including Tuncurry, has the highest average age of any location in New South Wales.

Source 8.10 Bribie Island has the highest average age in Queensland. It is suited to people who are looking towards retirement or are already retired.

For example, in New South Wales – especially in Sydney, where two-thirds of the state's under-15 population live – most young people live in the outer suburban growth areas of Rouse Hill, Kellyville, Bidwell and Lethbridge Park. Twenty-seven per cent of the population of these areas is under 15 years old.

It's a similar story in Victoria, where the growth fringe suburbs of Melbourne have the greatest proportion of people aged under 15. The areas of Taylors Hill, Roxburgh Park and Berwick had the highest proportion of children – 28% for all 3 suburbs.

The reason why these areas or suburbs have higher proportions of children is because land and houses are cheaper out on the urban **periphery**. This makes them an attractive prospect

periphery the edge or outskirts

Source 8.11 Aerial view of sprawling red-tiled rooftops, streets and road structure of typical southern suburbs of Sydney

Source 8.12 New housing is attractive for young couples on the urban fringe due to its cheaper prices.

ISBN 978-1-107-69012-7

Cambridge University Press

for young couples with children, because they can more easily afford the housing in this area. Often this housing is brand new and low density as well, which is an added incentive for these families. The demand for this kind of housing has a dramatic impact on the nature of cities because it encourages urban sprawl, which alters the size and shape of towns and cities.

ACTIVITY 8.3

1. Go back to the ABS website and look up the Census page for the area where you live. Click on the 'People' bar and go down to the section on age.
2. Find the percentage figures for the population of people aged 10–14 in your area. Compare it to the percentage for people aged 10–14 in your state and in all of Australia.
3. Suggest a reason why the local percentage differs (if it does) from the state and national percentages.
4. Suggest 2 ways in which the local area attempts to cater to the needs of people aged 10–14. Also suggest 1 new way in which the local community could cater to those people.

NOTE THIS DOWN

Copy the table below and conduct a SWOT analysis of what it would be like for a person your age living in a periphery suburb like Kellyville or Berwick. Write down 3 *strengths* of this kind of area, then 3 *weaknesses* of the area. Once you've done this, write down 3 *opportunities* that become possible in a high-density area, and then 3 *threats* that might become a problem for such an area.

Young people in periphery suburbs	
Strengths	**Weaknesses**
• • •	• • •
Opportunities	**Threats**
• • •	• • •

ISBN 978-1-107-69012-7

Case study 8.1

Community profile: Yamba, New South Wales

estuarine relating to or found by the tidal mouth of a river

Far north New South Wales is home to the town of Yamba, a town listed as the best town in Australia. Yamba is part of the largest **estuarine** system on Australia's east coast, sitting on the mouth of the Clarence River. The town is surrounded by Yuraygir National Park, the Pacific Ocean and rural land, as well as the Clarence River. Yamba has become famous for its safe surroundings, relaxed lifestyle and focus on the community.

According to the 2011 census Yamba's population is 6074 with an average age of 53 years. This average is 16 years above the Australian average. The number of people 50 years and younger is much smaller than those in the 50–80 age groups. For 93.5% of the population English is their first language. Very small sections of the community speak Spanish, Dutch, French, Italian and Cantonese.

51.3% of Yamba residents are married and 47.8% of homes are fully owned, with the median mortgage repayment of $1517 per month. 17.2% of houses are purchased by home loan mortgage and 31.8% are rented. Most families consist of couples with no children, or couples with no children under the age of 15 (most of the children now being independent).

The population of this coastal town doubles during the January school holidays due to its appeal to tourists as a way to escape the major cities and relax at clean beaches.

1. Explain why Yamba's average age of 53 is 16 years above the Australian average.
2. In the major city of Sydney 26.4% of the population speak English as their first language. Identify why this is such a low percentage in comparison to Yamba's 93.5%.
3. Suggest why the majority of homes in Yamba are owned and not rented.
4. Investigate why Yamba has been labelled the best city in Australia and list the reasons.

8.3 Debating demographics

Demographics allow us to measure and analyse specific human elements that influence a community or a place. But it's not always clear whether that influence is a good or a bad thing. As demographics change, so do societies, and there are many debates over whether changes are positive or negative – or both at the same time.

For example, if the level of car ownership increases in an area, it can be a positive thing – it means that people have more mobility, that there is more access to services and more money is being earned by local businesses. It can also be a negative thing – it can mean increased air and **noise pollution**, reduced funding for public transport and a greater demand for limited road and parking space.

noise pollution annoying and unpleasant levels of sounds, such as from aircraft or traffic

There are many different demographic topics and changes that can be debated; in this chapter we will look at 3 of them.

Population growth

The world's population is increasing over time, and has been doing so continuously for centuries. In 1800 it was around 1 billion people; now, a little over 200 years later, it's more than 7 billion people. Currently the rate of population growth is about 1.1% per year, which is lower than it was in the middle of the twentieth century. As the global population increases, so do pressures on the environment, food supplies and energy resources.

ISBN 978-1-107-69012-7

Cambridge University Press

According to the Census, Australia's population growth is around 1.6% per year, which is higher than the global rate. 42% of that growth is from natural increase (births), while 58% comes from migration and people moving here from overseas. Our population reached 23 million people in early 2013, and is expected to reach 24 million in 2016 (if the growth rate remains 1.6%). Just as with the rest of the world, this growth puts a strain on our natural environment and resources, as well as our social infrastructure – it means there are more people using services and looking for jobs.

However, that doesn't mean that population growth is entirely a bad thing. Australia has a very low population density – an average of 2.6 people per square kilometre, one of the lowest in the world – and in some regions this makes it very difficult for people to form communities, run businesses or gain access to services and resources. Most of Australia's population lives in the eastern states (Queensland, New South Wales and Victoria) and usually within a few hours' drive of the coast. As our population increases, cities and towns in those states become more crowded and expensive. This makes living in low-density rural areas more attractive, particularly for adult migrants who have just moved to Australia. An increase in population in these areas can help improve their economies and access to resources, leading to improved quality of life for these towns and communities.

Source 8.13 Heavy traffic in Sydney. Increases in Sydney's population would put further strain on its roads and transport infrastructure.

Geographical fact

The small country of Monaco has the world's highest population density. The latest record of the population density of Monaco was 17703.50 people per square kilometre. If you laid out the Melbourne Cricket Ground 10 times, it would be roughly the same size as the entire country of Monaco.

ISBN 978-1-107-69012-7

Cambridge University Press

NOTE THIS DOWN

Copy the table below and create an issues map about the effects of population growth. Write down at least 2 positive and 2 negative aspects of population growth and how it has affected Australia as a country. Once you have finished, compare your issues map to another student's and discuss your responses.

Has population growth been good for Australia?	
Positive	Negative

Income disparity

One thing that the 2011 Census showed was that average wages and incomes are rising in Australia. Our economy has been very strong for several years, especially when compared to the rest of the world, and most Australians enjoy a high standard of living.

But not all Australians are so fortunate, or so wealthy. According to the Australian Bureau of Statistics, the average adult income in 2012 was $1081.30 a week. Some people make more than that, and other people make less. In Australia, the top 10% of households (in terms of wealth) have a disposable income that is about 4.2 times as much as that of the bottom 10% of households. The gap between a society's wealthiest members and its poorest members is called income **disparity**, and it shows where there is a lack of equality in the society.

disparity the state of being unequal

Costs in an area tend to rise to meet higher incomes, rather than drop to meet lower incomes. If an area has many people with high incomes, prices and rents will usually increase because the owners of properties can demand more for their houses. Someone making less than the median income for an area may have difficulty meeting the costs of groceries, transport or house payments. They may decide to live in a cheaper area, but because those areas have less money in their economy, they often have fewer services like schools and shops and force a lower standard of living on residents.

Income disparity is a big problem for people on government allowances such as **Newstart** or the age pension. A person on Newstart collects a maximum of $248.50 per week, plus up to $61.50 in rent assistance, and many people collect much less than this. In many areas this is not enough to cover the rent of a house or apartment, so people must move to cheaper areas, often with fewer jobs, and share accommodation with other people. Life on Newstart and other allowances can be very difficult and leave people with no money, especially if they also have to support a family.

Newstart the system of social welfare payments for financial help provided by the Australian government

Increasing Newstart, the age pension and other allowances would make life much easier for these disadvantaged people and families. On the other hand, these increases would need to be funded by the government, which means taxes might have to be increased to pay for them.

ISBN 978-1-107-69012-7

Cambridge University Press

Source 8.14 The town of Stanley in Tasmania. Towns can be cheaper to live in than cities but may have fewer jobs and lower incomes.

ACTIVITY 8.4

1. Go back to the ABS website and look up the Census page for the area where you live.
2. Look at the median weekly household income for the area and compare it to the median monthly mortgage repayments. Calculate how much income the average household would have left each month after paying their mortgage costs.
3. Compare the median weekly household income to the median weekly rent. Calculate how much income the average household would have left each week after paying the rent.
4. A young person on Newstart would receive a maximum of $310 a week. Calculate how much money that person would have left each week if they had to pay the median weekly rent in your area. Would they be able to pay the rent at all?

Multiculturalism

One of the most controversial aspects of demographics is the topic of ethnicity and the location of ethnic people within towns or cities around Australia. The Australian population is one of the most **multicultural** in the world; throughout our history, Australia has been subject to immigration from all corners of the world. From the invasion of Europeans that first established towns and cities, to the the arrival of Chinese workers attracted by the gold rushes of the 1800s, to the mass migration of eastern Europeans after World War II, to an influx of South-East Asian people during and after the Vietnam War, modern Australia has been built on the back of immigration.

multicultural describing a society that reflects and is open to many different cultures

While this migration of people into Australia has forged our multicultural society, it has also created tensions and controversy about how migrants have settled into the towns and cities of Australia. Many new immigrants have moved to areas where they can get services that they recognise and associate with people that speak their own language. This is understandable, as it helps them feel comfortable in their transition to a new country. This concentration of an ethnic group into a localised area is known as an **enclave**. There are many different views on the development of these enclaves, illustrated in Source 8.15.

enclave a small, distinct area or group that is enclosed or isolated within a larger one

ISBN 978-1-107-69012-7

Cambridge University Press

Geographical fact

New York City has a long history of international immigration. Approximately 800 different languages are spoken across New York, making it the most linguistically diverse city in the world.

Source 8.15 Views on ethnic enclaves

Views for ethnic enclaves	Views against ethnic enclaves
• Provides support for new migrants • Provides familiarity of culture and language to migrants • Gives migrants access to services, products and resources that they are accustomed to • Provides opportunities to access other food and cultures, promoting multiculturalism • Provides opportunities to develop economic interests and businesses to cater for the ethnic group	• Creates a dependence on 1 area for services • Creates issues with the provision of services such as education. Being able to provide services to large numbers of students could be difficult. • People become so integrated into their own culture that they might lack the need to engage with the wider society.

RESEARCH 8.2

Research an area in an Australian city or overseas city that would be characterised as an enclave.

1. Identify the characteristics that make it an enclave.
2. Identify the reasons why the ethnic group has moved to this area.
3. Explain the advantages and disadvantages for that ethnic group in that area.

Present your findings in a report. Be sure to include ABS data in your analysis.

Source 8.16 The Australia Day parade in Adelaide celebrates our society and its multicultural nature.

8.4 Factors influencing settlement choices

Generally we can place the factors that can affect settlement choices into the following categories: social, historical, economic, environmental, political and technological. Of course, not all choices are limited to just 1 category. In reality, many of these factors combine to determine an individual's settlement choice.

Social

To what extent do societal factors influence an individual or family/group decision in a choice of settlement? An individual or family may have a strong **affinity** with a place. This may be a generational phenomenon, such as when a farm will be handed down through a single family, with each generation working the land in turn. An Aboriginal family may also have strong affinity with and a sense of belonging to a place that their ancestors have inhabited for thousands of years. An immigrant family may move to an area shared by people with the same cultural experiences and roots.

affinity a natural liking for or attraction to a particular person, place or idea

Historical

Similarly, historical factors may also come into play. If a settlement has historical roots in, say, mining or tourism, this factor can be very strong. Settlements such as Broken Hill (NSW) and Bendigo (Vic) developed due to the wealth of minerals below the surface. This may result in generational choice while the minerals are accessed as a resource. Even chance may come into play: in 1788, Captain Arthur Phillip and the First Fleet happened upon Port Jackson (Sydney) as the site of a new convict settlement ahead of nearby Botany Bay. Ready access to freshwater was the main driver behind that decision.

Economic

Clearly, economic factors will influence settlement choices. The mining activity in Western Australia and Queensland is driving an economic situation there, boosted by a high international demand for resources. The need for skilled workers in certain remote locations is encouraging some people to move to these areas with an expectation of attractive wages and reasonably secure employment.

Geographical fact

Australia is the only nation to occupy an entire continent. Its land mass is nearly 7.7 million km^2 and it has a coastline of 36735 km.

Environmental

This factor is interesting, because it influences many levels in society. Some individuals or families may choose to live in an area for its attractive environmental qualities and amenities. Of course, an attractive environment is in the eye of the beholder. An individual may be attracted to the coastline: the so-called **sea changer**. Alternatively, an individual may move into the countryside away from the city; these people have been dubbed **tree changers**.

sea changers colloquial term for people who opt for what they perceive as an improved quality of life by the coast

tree changers colloquial term for people who opt for a perceived improved quality of life by moving to the countryside

Political

Individuals or families in Australia probably like to think that their settlement choice is beyond politics, but for some the policies of state or federal governments may significantly influence their choice of settlement. In Australia, the capital city of Canberra was founded in 1913.

ISBN 978-1-107-69012-7

public servant a person who holds a government position by election or appointment

A settlement was begun from scratch, primarily to deliver a capital for the nation. The site of this capital was the result of searching for a place that would satisfy the stakeholders in the new states of Australia and also sidestep the rivalry between Melbourne and Sydney. Many a **public servant** has been sent to 'the bush' due to government policies like decentralisation.

Technological

Some settlements are the result of the rise of new technologies in society. Internationally, the famous Silicon Valley in the USA is a case in point. This area specialises in advanced technologies, particularly computer hardware and software. These industries tend to attract each other to the same location through **economies of scale**, where an increased level of production will lower the average costs to run the business. A less dramatic example in Australia is the Docklands development in Melbourne, Digital Harbour, which aims to attract investment in the technological field and become a major hub for IT in the Southern Hemisphere.

economies of scale a fall in average costs resulting from an increase in the scale of production

Source 8.17 Office buildings in (top) Silicon Valley, USA and (bottom) Melbourne, Australia

NOTE THIS DOWN

Copy the table below and complete a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of how living in Australia affects your choice of settlement.

Living in Australia	
Strengths	**Weaknesses**
• Relatively strong economy given our isolation from the rest of the world and our small population	• Majority of land mass is uninhabitable (desert).
Opportunities	**Threats**
• With advancements in technology, we may be able to sustain our growing population with more of our society moving inland.	• Over-reliance on our resources to fuel the economy (iron ore, coal, gas)

ISBN 978-1-107-69012-7

Case study 8.2

Silicon Valley, United States of America

Silicon Valley is a region located 40 km south- east of San Francisco in the United States of America. It generally owes its wealth to the rise of computer-generated employment. The term 'Silicon Valley' was originally coined in the 1970s, but did not become widely used until the 1980s. The term arises from the use of silicon in **semiconductors**, the manufacture of which was one of the Valley's primary industries. With the rise over the last few decades of the home computer, improved telecommunications, the internet and tertiary-based employment, including services and **telecommuting,** Silicon Valley companies have been at the forefront of an advancing industry. These companies tend to congregate together because of their highly specialised workforce and the economies of scale that are created as human skills, software and hardware are built in the same area. This expertise tends to feed on itself to the point that all companies have to have a presence in this area or be seen to not be at the forefront of cutting edge technology.

semiconductor a device – usually containing silicon – which conducts electricity. Semiconductors are commonly very small and can be found in thousands of products such as computers, phones, appliances and medical equipment.

telecommuting working at home by using a computer that is electronically linked to your place of employment

Source 8.18 The location of Silicon Valley in California, USA

1 Suggest reasons why this region attracted employment opportunities.

2 Investigate what computer-based companies are located in this region. Why is it critical for companies to be represented in this region?

3 Compare Silicon Valley with another location that developed due to a primary industry. Graph its population growth from the beginning to now.

Case study 8.3

Canberra, Australian Capital Territory

The capital of Australia, Canberra, is the classic case study of political factors driving and determining settlement choices. In the nineteenth century, the rivalry between Melbourne and Sydney as to which was the dominant city was becoming intense. Both cities laid claim to the right to be regarded as the capital city of the Federation. In 1913, it was determined that a new city would be developed to offset this rivalry and so the idea of a capital city was born. An international competition was organised to determine a plan for the new city, and Walter Burley Griffin, an American architect, was determined the winner with his innovative design of a 'garden city'. A competition was also held to find a name of the new city, and so 'Canberra' was born. While Canberra was under construction, Melbourne was the temporary home of the Australian Parliament. The development of Lake Burley Griffin was not completed until 1964.

ISBN 978-1-107-69012-7

Today, Canberra is home to over 367 000 people. A city that began from nothing has now outgrown its modest political administrative origins, and is now generating economic growth, partly through its own critical mass of people. Clearly, such a population requires goods and services, such as medical and educational specialisations. The main employer in such a city is still the government. Public servants, as they are called, are employed by the government of the day to provide a range of government services, such as defence, education, health, disability services and transport. Improved freeway connections and an upgraded airport have improved opportunities and development potential for the future.

1. The year 2013 marks a birthday for the city of Canberra. Calculate what the birthday will be.
2. Investigate and list the job opportunities that may exist for non-skilled workers in Canberra.
3. Discuss the sacrifices an individual (who doesn't necessarily live in Canberra) may need to make if they are offered government employment in Canberra.

Source 8.19 Map of Canberra

Case study 8.4

'Fly in fly out' in Western Australia

The phenomenon of 'fly in fly out' during the last decade in Western Australia is an interesting case of the balance between work and settlement choices. Western Australia has been experiencing significant growth in the mining sector, particularly in the areas of iron ore production, diamond mining and natural gas exploration. 'Fly in fly out' is an expression used to describe workers, such as those in the mining industry, who fly in to their place of employment, live and work there for a short period of time, and then fly out until the next required roster. This has been steadily increasing in the northern regions of Western Australia in the last few years. As the mining boom took hold, employees were having difficulty in attracting skilled workers to remote sites. One approach was to provide temporary accommodation while a worker did a 4-week shift. Rather than develop a so-called mining town, with the entire infrastructure we generally take for granted – shopping centres, hospitals and schools – the main focus was on providing temporary living quarters. Critics of the 'fly in fly out' approach argue that such temporary accommodation means mining towns will never develop appropriate infrastructure that will lead to natural growth in facilities and amenities. Workers who fly in and fly out will not become part of the fabric of the community and not get involved in local affairs, such as local sporting clubs and service clubs. There is evidence, critics argue, that workers' mental health may be affected by social dislocation.

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This reality cuts to the core of settlement choices. Is a worker who flies in for 4 weeks making a settlement choice or a work choice? And are the 2 potentially at odds with each other?

1 Mining and port towns such as Port Hedland, Karratha, Newman, Marble Bar and Argyle are at the forefront of the 'fly in fly out' experience. Locate these towns on a map of Western Australia.

2 Analyse the social problems that could arise for mining communities as a result of 'fly in fly out' working conditions.

3 Suggest reasons why mining companies may be reluctant to provide infrastructure in nearby towns.

Source 8.20 Karratha, Western Australia, is a 'fly in fly out' destination.

Case study 8.5
Bendigo, Victoria

Bendigo is located 150 km north-west of Melbourne, Victoria. Bendigo is internationally famous as the site of one of the biggest gold rushes in human history. This region in central Victoria was home to the Dja Dja Wurrung people. Usually a settlement would develop on a watercourse to ensure reliable drinking water, but the locality only had Bendigo Creek, with its sporadic flow. It was the spate of gold discoveries in the mid-nineteenth century that led Europeans and people of the colony of New South Wales to travel south in the hope of striking it rich. The fledgling town of Melbourne saw an **exodus** of would-be miners to the goldfields. The town of Bendigo quickly went from a tent city to one with more substantial buildings. A railway link was constructed to link the goldfields to Melbourne. Clearly, this settlement's existence is due mainly to historical factors. Once the settlement was established, however, other factors came into play. Once the gold started to run out, Bendigo had to find other sources of work and income to justify its

exodus the departure of a large number of people

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existence. The rise of manufacturing in the twentieth century, and Bendigo's role as a service centre for surrounding agricultural pursuits, ensured the town's future.

In the latter part of the twentieth century, Bendigo became a key service centre for regional Victoria. With a growing population, services such as hospitals and schools were needed, and provided more employment in the city. In recent years, the development of the Calder Freeway reduced travel time to the capital city of Melbourne significantly, slashing this to less than 2 hours. In addition, there have been improvements to rail networks, such as line repairs, **rolling stock** and increased numbers of timetabled trains. The result of improved transport infrastructure and the phenomenon of so-called 'tree changers' has seen a significant rise in people relocating to the region along the Calder corridor.

rolling stock trains or other vehicles used on a railway line

Some people are moving from Melbourne and relocating to towns along the Calder corridor such as Gisborne, Kyneton, Castlemaine and Bendigo. What is particularly interesting is that some people are living in Bendigo and commuting to the city of Melbourne for work and also some people from the city are commuting to Bendigo for educational services and employment. Regarding the tree changers, many are relocating to the region in search of a better rural lifestyle. So while Bendigo's development can be seen in an historical context, other factors influencing settlement choices have come into focus. The cost of living in major cities in Australia is also forcing many people to live on the urban rural fringe of a city or relocate to rural and regional centres where, generally speaking, the cost of housing is significantly lower. Lower housing prices are attracting people to live in places such as Ballarat and Bendigo. Certainly, social, economic and environmental reasons are key drivers of Bendigo's present and possibly its future economy.

1. Draw up a graph that illustrates Bendigo's population from 2006 and the forecast population growth until 2031. Is it declining or increasing?
2. Explain reasons why it might have been difficult for Bendigo to initially reinvent itself after the gold ran out.
3. Justify why Bendigo has the potential to become a 'boom town' of the future.

Source 8.21 (Left) Poppet head (framework) over an abandoned gold mine in Bendigo, Victoria. (Right) Bendigo Town Hall

ISBN 978-1-107-69012-7

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8.5 Where Aboriginal and Torres Strait Islander people live

Britain's First Fleet arrived in January 1788, and took ownership of Australia. In European international law the principle for the take-over of a continent was the notion of ***terra nullius***. This meant that according to British law the Aboriginal lands belonged to the Crown.

terra nullius land belonging to no one

This idea that Australia belonged to no one was not because the British did not see Aboriginal people, but because Aboriginal and Torres Strait Islander people did not farm land or build permanent dwellings as Europeans did. *Terra nullius* means that the land has no owner, and so Britain believed they had the right to take possession of Australia without a treaty.

In 1992, the High Court of Australia recognised for the first time that Australia was not *terra nullius* at the time of European colonisation. This decision, known as the Mabo decision, recognised that Indigenous people had continuing rights and interests in their land and waters in accordance with their traditional law and custom.

There are many reasons why Aboriginal and Torres Strait Islander people chose to live in their country or place, or would prefer to if they had the choice.

An important element of Indigenous society is that land is central to its economic, spiritual and cultural basis.

Recent Indigenous population statistics indicate that people aged 5–19 years were among the most likely to leave remote and very remote areas. One of the contributing factors for younger people moving away from remote and very remote areas is to attend school. Aboriginal and Torres Strait Islander people aged 20–39 years were most likely to move to major cities to find work.

The Census of Population and Housing is a descriptive count of everyone who is in Australia on 1 night, and of their accommodation. In 2011, there were 548 370 people identified as being of Aboriginal and/or Torres Strait Islander origin and counted in the Census.

This represents 2.5% of the population as recorded in the 2011 Census. Source 10.7 is a breakdown per state.

Source 8.22 Population breakdown of Aboriginal and Torres Strait Islander people per state

State or territory	Number of Aboriginal and Torres Strait Islander people	Proportion of entire state population who are of Aboriginal and Torres Strait Islander origin (%)	Proportion of the Australian total Aboriginal and Torres Strait Islander population who live in the state (%)
NT	56 779	26.8	10.4
WA	69 665	3.1	12.7
NSW	172 624	2.5	31.5
VIC	37 991	0.7	6.9
SA	30 431	1.9	5.5
TAS	19 625	4.0	3.6
QLD	155 825	3.6	28.4
ACT	5184	1.5	0.9

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RESEARCH 8.3

Use the internet to research the Mabo decision. Using the information you have gathered, produce a time line of events that led to the decision. Include all significant events that occurred from 1974 to 1998. Suggest how this decision changed the shape of Australian society in a short paragraph.

8.6 Different scales and stages of life

In this section we will examine how the stages of life's journey can affect settlement choices.

Young people, singles, couples and beginning families

The increasing cost of home ownership is becoming a concern in Australian society. The so-called 'Great Australian Dream' of home ownership is becoming increasingly difficult to achieve for a variety of reasons. The cost of the initial deposit for a home, the price of homes in large cities and the link between real income and mortgage repayments have caused a shift in attitudes to home ownership among the young. Some younger people are choosing to live with their parents until they can afford to move. The so-called 'empty nest syndrome' when offspring leave the family home is becoming less of a certainty as young adults postpone leaving home. Young people may also opt for shared accommodation in rental properties. This puts strains on older couples that may have expected their children to have left home, particularly as they approach retirement. Beginning families need to juggle home and work commitments to cover mortgage or rental costs. Decisions need to be made about costs of living, commuting distance and life–work balance.

Some people (young or mature) choose to live on their own in a dwelling. This may be the result of partnership breakdown or a lifestyle choice. ABS data are showing that more people are choosing a solitary lifestyle.

Middle-aged couples and teenage children

Middle-aged couples with or without children may opt for the suburbs of major cities. The cost of properties will rise considerably closer to the city centre, so some couples choose to live in cheaper suburban and outer suburban homes. A significant issue is whether they are close to their employment, or what the likely commuting distance is. If the couple have children, another consideration is the choice of school. Some people will even buy into a neighbourhood because it is near a school with a good reputation. Property values actually rise or fall if the reputation of a school becomes general knowledge. Property prices also rise or fall depending on the perceived prestige or otherwise of a particular location. As demand outstrips supply, property prices increase

Geographical fact

One in 4 Australians aged between 24 and 35 now live with their parents. This number has been growing over the past 20 years.

ISBN 978-1-107-69012-7

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Source 8.23 The western suburbs of Sydney

for sought-after neighbourhoods. Data from the Australian Bureau of Statistics and published housing prices bear this out. So choice in this circumstance is limited by personal income or the capacity to repay a mortgage.

Older age

As people age and their offspring move out into their own homes, they may look to downsize from a larger house to a smaller dwelling in keeping with their new needs. An individual or couple may move into a smaller dwelling in an area they are familiar with, or move to a new location entirely. Some couples or individuals may downsize to an apartment, a small townhouse or a unit. If medical concerns are an issue, a couple may move into independent living sites, but with medical facilities on call.

Very old age

When couples or individuals near the end of their lives, they may choose to move into a nursing home facility or a retirement village with medical support. Some may be supported by adult offspring or still choose to live independently. This period of life requires the same level of clear decision-making as when choosing a first home. Personal health issues may take choice right out of the equation.

Lifestyle choices

At any stage of the life cycle an individual or couple may make a lifestyle choice. This choice may be limited by personal health issues or personal wealth. People who have had enough of the 'rat race' may choose to move out of a city to a more idyllic rural or seaside setting. These have colloquially become known as 'tree changers' or 'sea changers'. This recent phenomenon has the potential to create real problems for local councils and governments as they try to predict future growth trends in our society. Not only is this challenging from a planning viewpoint, it also poses environmental challenges. People chasing the dream of a picturesque coastal town or unspoilt village may find themselves unwittingly causing its deterioration. Coastal councils in Australia are struggling to zone areas from rural to urban development, and an attempt to keep the aesthetic qualities of coastal and rural resorts is being seriously undermined. Areas in Australia under pressure of overdevelopment include the Surf Coast (south-east of Geelong), the Gold Coast and its hinterland in south-east Queensland, and most villages along the New South Wales coastline.

ISBN 978-1-107-69012-7

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8.7 Limited choices

As we discuss choice in this chapter, we must continually revisit the real prospects of personal choice.

For some people, particularly in poorer parts of the world, the idea of choice is but a dream. The cycle of poverty that many people in the world experience is a harsh reality that severely limits their right to **self-determination**. Alternatively, people's choice may be limited due to cultural expectations in different parts of the world. The lack of education available to women in some poorer nations is one that is partly cultural. Combating the limited opportunities for women in these nations is part of the challenge of reducing poverty and improving living standards and consequential real choice.

self-determination the essential right of all people to freely decide their own political status and to freely pursue their own cultural, economic and social development

ACTIVITY 8.5

1. Besides the lack of education available to women, suggest 3 other choices poorer nations might have to face.
2. Compare the choices faced by poor and developed nations. Are they similar? Why or why not?
3. Describe some of the choices that are available to you as a young person living in Australia.

Source 8.24 A school in Kenya, Africa

8.8 Where people will live in the future

Predicting the future is a tricky business and fraught with potential error. Planning authorities in state and federal governments rely on the Australian Bureau of Statistics (ABS) to try to predict potential growth trends. In a country like Australia, the government is somewhat limited in its ability to control or manage growth trends. It does, however, have some tools at its disposal to encourage growth in a certain direction. These include:

- release of government land to private development
- planning controls to limit growth in environmentally sensitive areas
- zoning laws restricting land use
- government jobs being available in rural or regional areas
- cash incentives for relocation of jobs.

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As you can see, this is not really an impressive list of controls, but more a way of encouraging individuals to settle in certain places.

At present we know that the population trends in Melbourne, Sydney and the Gold Coast will probably continue in the short to medium term. The shift towards coastal living appears to be still strong, with growth in rural areas also likely to continue in places that are still within a 2-hour driving distance of major metropolitan centres.

ACTIVITY 8.6

Look at the following list of so-called 'family friendly' cities.

1	Launceston (Tas)	7	Hobart (Tas)
2	Canberra (ACT)	8	Darwin (NT)
3	Toowoomba (Qld)	8	Bunbury (WA) (equal 8th)
4	Albury/Wodonga (NSW/Vic)	10	Bundaberg (Qld)
5	Adelaide (SA)	14	Melbourne
5	Perth (WA) (equal 5th)	23	Sydney

Source 8.25 Family friendly cities in order of 'friendliness'

1. Suggest reasons why smaller cities may be regarded as more 'family friendly'.
2. Identify 4 or 5 factors that might limit an individual's personal choice of settlement.
3. List 2 potential reasons why governments in Australia are so limited in their ability to control and manage population growth.

Geographical fact

In 2007, for the first time in human history more people are living in cities than in rural areas.

RESEARCH 8.4

Use the internet to gather information about settlement choices. You will find a number of useful links at www.cambridge.edu.au/geography7weblinks.

In groups, select 1 of the sites and investigate the information available. Then select a settlement and research its climate, public transport and any other statistics. Share your findings with the rest of the class in an oral presentation.

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FIELDWORK 8.1 EXPLORING YOUR LOCAL COMMUNITY

Aim

To analyse how your local community functions in the provision of goods and services, transport and utilities and recreational space and activities. Your local community may be a small town, region, suburb or city.

Method

Define the borders and parameters of your local community. Your community must be able to be mapped within clear boundaries.

Preparations

Find a map of your local community and indicate the areas that will be visited and studied (you must visit at least 3 sites). You will also need to take a camera or phone, a list of questions based on the 'data collection' section below, paper (in a clipboard) and a pen.

Data collection

As you travel along the suggested path on this fieldwork trip, stop at various sites and ensure that you collect the following information in preparation for your fieldwork report:

1. List all the public transport available in your community. Take photos of some of these. Mark the location of these on your blank map. Provide a key to display your data collection.
2. Show on your blank map any recreational spaces in your community.
3. Is there any evidence of visible pollution or rubbish in your community?
4. Locate on your map any available community services, such as senior citizens clubs, swimming pools and skate parks.
5. Locate on your map examples of health services, doctors, infant welfare centres and hospitals.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map
Page 3	Introduction – a brief description of the study sites
Pages 4 and 5	Description of uses and photos
Page 6	Table of usage: effects of use (positive or negative, short-term or long-term)
Pages 7 and 8	Description of effects of use, sketches and/or photos
Page 9	Association between use and effects of use
Page 10	Table or written description of management strategies
Page 11	Photos of sketches of management strategies
Page 12	Evaluation of these strategies
Page 13	Appendix, bibliography, glossary

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NOTE THIS DOWN

Copy the table below and summarise what you have learned about settlement choices.

Settlement choices		
Factors affecting settlement choices	Examples	Future projections

ACTIVITY 8.7

1. Identify where you would like to live in the future.
2. Explain why you chose this location by outlining the influencing factors.
3. Compare the results with a friend and consider why there are similarities and/or differences.

RESEARCH 8.5

Construct a pamphlet that advertises the place where you would like to live in the future. Include photos and a catchy slogan, and list factors as to why your chosen place is the best.

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Chapter summary

- Demographic characteristics are the features that make up a population. They include age, gender, ethnicity, income, religious affiliation, educational level, employment and dwelling structure.
- Demographics are useful in gaining a more detailed understanding of the population of your local suburb, town or city. It also provides governments with information on how they need to cater for that population in the future, such as infrastructure development (schools, hospitals and aged care facilities).
- Settlement choices may be influenced by social, historical, economic, environmental, political and technological factors.
- An important element of Indigenous society is that land is its economic, spiritual and cultural basis.
- Some individual or family choices may be limited by personal circumstance, cultural factors, wealth and attitudes to perceived quality of life.
- Settlement choices can change over the course of an individual's life cycle.

End-of-chapter questions

Multiple choice

1 What are demographic characteristics?

A A population of people
B People located in a certain area
C Features that make up a population
D Concentration of people in a rural area

2 What is an enclave?

A A sparsely populated area
B A rural area associated with agriculture
C A concentration of an ethnic group into a localised area
D A high-density residential area

3 What are the factors influencing settlement choices?

A Political
B Economic
C Technological
D All of the above

4 The Australian government has the power:

A to make people live where they want
B to move people interstate
C to control people's settlement choices
D to plan for future growth

5 Settlement choices:

A are government-controlled
B are privately determined
C are always determined by employment
D none of the above

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Short answer

1 Suggest why most aged people want to live on the coast.

2 List the key reasons why young families move to the outer suburbs of towns and cities.

3 Suggest what individuals could do to empower themselves to take control of their settlement choices.

4 Identify the role of government in improving an individual's settlement choices.

5 Account for some reasons why the increasing cost of home ownership is becoming a concern in Australian society.

Extended response

In a short essay, explain how multiculturalism has transformed the demographic characteristics of Australian society.

Source 8.26 Cabramatta in Sydney's west is famous for its large Asian population.

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9 Liveable places

Source 9.1 The view of Melbourne from Brighton beach

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Before you start

Main focus

What makes a place liveable varies according to history, climate, location, services and personal choice.

Why it's relevant to us

The spread of people across the landscape is very uneven and this places pressure on governments to provide access to basic services such as schools, hospitals and roads.

Inquiry questions

- What makes a place liveable?
- Can you observe these characteristics? If so, what are they?
- How can you measure those aspects that are not visible or observable?
- What do all places have in common?

Key terms

- Aesthetics
- Country
- Density
- Distance
- Distribution
- Environment
- Location
- Perceptions
- Personal histories
- Place
- Proximity
- Space

Let's begin

For most of us, the place where we live will be determined by our parents and their decisions. Often they have links with country and place that go back for centuries. However, for many contemporary Australian families the choice of a place to live is a more recent decision and likely to be linked with employment, personal mobility and lifestyle choices. What is important to understand is that the final choices about where people actually live are not always made by individuals, but are more likely to be the outcome of complex decision making involving these factors. While for some people the choice of where to live is predetermined by personal histories and local culture, for other people the concept of a highly liveable place may be connected with access to amenities that could be found in places spread across the country or indeed anywhere in the world.

Wherever we live there is always an element of 'what is, what could be and what if'. Everyday living includes meeting our basic needs as well as planning for a future over which we have some control or that gives us a sense of purpose or wellbeing. A liveable place is a personal construct of our lived experience and imagination as well as a product of urban planners, government legislation and entrepreneurs with access to wealth-creating resources.

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9.1 What makes a place liveable

Depending on where you live, the answer to the question 'What makes a liveable place?' could vary considerably. Consider the following quotations from 12-year-old students respectively located in rural Queensland, metropolitan Melbourne (outer suburbs) and coastal Tasmania:

> Sometimes the whole sky seems to light up with stars and shapes and maybe other places.
>
> I like the quiet, the space … the birds. Not the flies or drought.
>
> My family came to Australia from Sri Lanka when me and my brother were little. We like it here. There's lots to do and I can get a good education.
>
> I like going to the city in the weekends. Sometimes we go to the football or a film. I really like going to the beach.
>
> The fishing is really good – we fish on the beach, then barbecue them fresh.
>
> Our footy team is winning this year – we may go to town for the finals.

Embedded in the quotations are references to family, education, nature, sport, climate, space, location and access to entertainment and city life. If these students were to ask their parents and older community members the same question – 'What makes a liveable place?' – the responses might include many other aspects, such as aesthetics. A useful exercise to test this idea is to ask the same question of several people of different ages, genders and, if possible, ethnicities.

Liveability myths

Assuming you have had conversations about the meaning of liveable lifestyles with several people with different experiences, then you probably have access to a range of opinions. Take some time now to reflect on the answers you obtained – was there anything that changed what you thought you knew about liveability? What kinds of alternative perspectives emerged from this research? Did distance and location come up? Opposing views are a likely outcome, and these can lead to useful discussion and debate. One of the important things that should come out of an activity like this is the realisation that some long-held beliefs about places are in fact myths. That is, these 'beliefs' do not always hold true.

Source 9.2 The Sydney Light Rail network in Haymarket

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NOTE THIS DOWN

Copy the table below, which lists the characteristics of 'liveable places'. Place a tick in the appropriate box and then list in order of importance. Discuss the reasons for each person's preferences.

Characteristic	Me	Parent/ grandparent	Other person 1	Other person 2
Clean air and water				
Nearby hospitals and schools				
Access to good living wage and low poverty levels				
Affordable housing				
Efficient public transport				
Car friendly				
Safe neighbourhood				
Emergency services				
Recycling and waste management				
Sports fields				
Income support including pensions				
Social justice				
Large shopping centre				
Voting rights				
Cinema and entertainment centre				
Museum and art gallery				
Low crime rates				
Family and friends nearby				
Nature reserves and parks				
Inclusive communities				
Medical centre				
High speed internet				
Disability access				
Birds and wildlife				
Retirement housing				
Cultural festivals				
Banks				
Other – add to this list from all responses				

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ACTIVITY 9.1

In small groups discuss how the following might be considered myths about place liveability:

1. High income guarantees happiness and success in life.
2. Rural lifestyles are less attractive than urban lifestyles.
3. Living on the edge of a large city is better than living in the country.
4. Nature and urban landscapes are incompatible.
5. Access to education and services requires face-to-face contact.
6. Living sustainably is not possible in big cities.
7. Living on the coast is best.
8. Big houses provide the best lifestyle.
9. Living in high-density housing removes privacy.
10. Caring for the environment is the responsibility of local government.

Consider the following quotation:

> He let his mind drift as he stared at the city, half slum, half paradise. How could a place be so ugly and violent, yet beautiful at the same time?
>
> p. 7, Chris Abani's book *Graceland*, published by Noble and Farrar, Straus and Giroux, 2004

If we reflect on Abani's observation, we find several contradictions that show the merits of thinking critically about myths. He casts his gaze on what we must assume are slums built alongside expensive luxury houses, and seems to acknowledge the simultaneous ugliness and beauty of them. How can this be so?

The first myth noted is that 'high income guarantees happiness and success in life'. The SWOT analysis below aims to show how this can be regarded as a myth:

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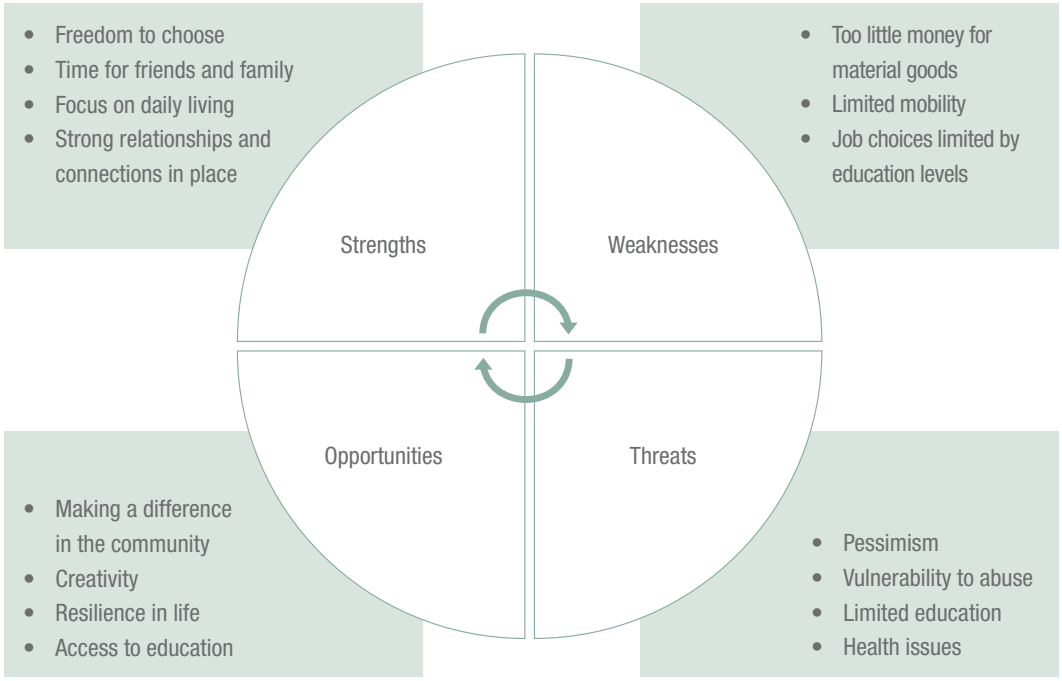
The opposite of this myth, that 'low income guarantees happiness and success in life', is equally questionable. The SWOT analysis for this myth might look like the following:



What are the similarities and differences between these 2 SWOT maps? A discussion of the differences might bring in topics like health and wellbeing and a sense of purpose and optimism about the future, as well as pessimism about issues that cause concern and worry about personal futures. You may also consider how these income differences may affect lifestyles and opportunities in rural, regional and urban locations. After all, what may appear to be examples of living in poverty or affluence can really mean something quite different to the residents.

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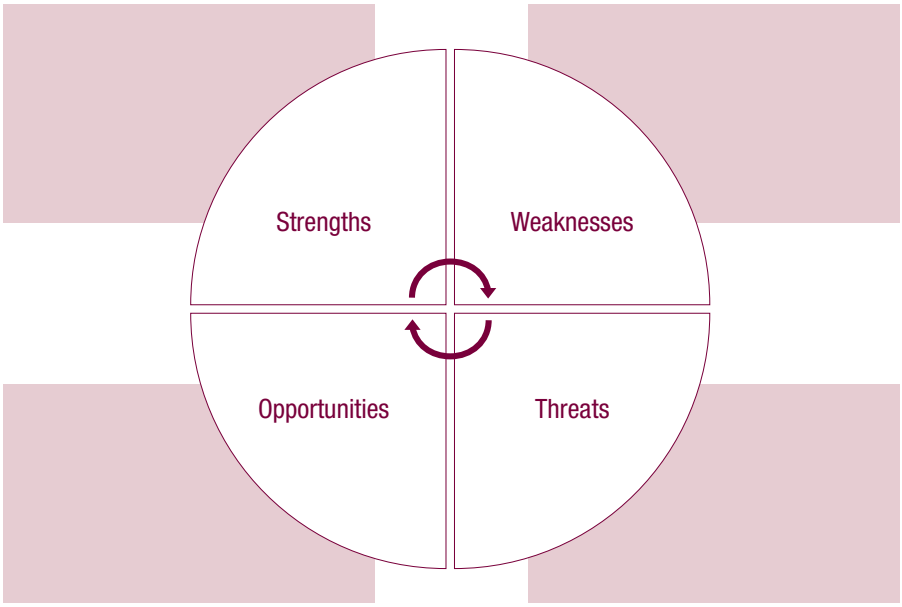
NOTE THIS DOWN

Copy the graphic organiser below; select 1 of the 'myths' in Activity 9.1 that has not already been used as an example and complete the SWOT analysis.



9.2 Observable characteristics

Observable characteristics of highly liveable places can generally be measured. The most obvious indicator is population. More than half of the world's people live in cities. Because this is such an important characteristic of population **distribution**, we need to look closely at the characteristics of cities and consider why people seek them out as their place of choice to live. However, this does not mean that rural and regional places do not have their advantages.

distribution the way in which something is shared out among a group or spread over an area

Megacities and influence

Megaglobal cities are a twenty-first century phenomenon, with many of the newer members of this club located in Asian and developing countries. Source 9.4 includes cities around the world ranked first by population, next by measures of global influence, third and fourth by liveability and in the fifth column by infrastructure. Notice that there are 2 rankings provided for liveability and they differ. The reasons can be complex and will have much to do with the ways in which the surveys were conducted, including the variables that may or may not have been included in the decision-making process. You may like to speculate on the reasons for the differences in the scales. The last scale rankings based on infrastructure may provide some clues. Whatever the reasons, the important message from these scales is that they are not fixed. Like the liveability myths, much depends on the views and biases held by the data collection agencies.

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Source 9.3 Vancouver, BC, Canada, is one of the most liveable cities.

Source 9.4 The top 10 cities globally in terms of population, services, liveability and influence

Population[a]	Global influence[b]	Liveability[c]	Liveability[d]	Infrastructure[e]
1 Tokyo	New York	Vienna	Melbourne	Singapore
2 Jakarta	London	Zurich	Vienna	Frankfurt
3 Seóul	Paris	Auckland	Vancouver	Munich
4 Delhi	Tokyo	Munich	Toronto	Copenhagen
5 Shanghai	Hong Kong	Vancouver	Adelaide	Düsseldorf
6 Manila	Los Angeles	Düsseldorf	Calgary	Hong Kong
7 Karachi	Chicago	Frankfurt	Sydney	London
8 New York City	Seoul	Geneva	Helsinki	Sydney
9 Sao Paulo	Brussels	Copenhagen	Perth	Hamburg
10 Mexico City	Washington DC	Bern	Auckland	Vancouver

a World Atlas, see www.cambridge.edu.au/geography7weblinks

b A T Kearney, see www.cambridge.edu.au/geography7weblinks

c Mercer Rankings 2012

d Economist Intelligence Unit's 2011 and 2012 Global Liveability Surveys

e Mercer's City Infrastructure Ranking 2012 is based on measures of the following: electricity, water availability, telephone, mail, public transportation, traffic congestion and airport effectiveness. See www.cambridge.edu.au/geography7weblinks.

ISBN 978-1-107-69012-7

Geographical fact

The World Bank considers one of the major challenges for all big cities is waste management, including sewerage. Their research indicates that there are around '3 billion residents generating 1.2 kg per person [of waste] per day' (1.3 billion tonnes per year)!

Australia has 4 cities included in these rankings, with Melbourne taking the liveability jackpot for 3 consecutive years. The Economist Intelligence Unit's 2011, 2012 and 2013 Global Liveability Surveys place Melbourne at the top of their lists. One of the reasons given was that:

> It is impossible to get lost in Melbourne. Streets are arranged in a grid, with very clearly written signs and pedestrian signals are located at every intersection. (See d in Source 9.4.)

Source 9.5 Top of class: Vienna, Austria, (left) and Melbourne, Australia, (right) are considered by some to be the most liveable cities in the world.

On the environment, observations included:

> We did not see any traffic cops in Melbourne.
>
> Though not as spick-and-span as Singapore, Melbourne is green, with numerous parks and gardens … Pollution is nonexistent.

On the low crime rate:

> The murder rate in the city is only 2.7 per 100 000 people (compared to 4.8 in the United States). When we walked home from the theatre at 11 p.m., we did not worry. Streetlights were on and, though we were the only people on narrow lanes, we felt totally safe.
>
> Hotels or malls had no guards and nobody searched bags or packages for bombs.

ISBN 978-1-107-69012-7

On culture:

Melbourne abounds in culture, from graffiti art on city walls to museums of all sorts.

The food is fantastic: Italian, Chinese, Thai, Japanese, French, American (steaks), English (pies), Australian (fish and chips). Even McDonald's is lighter and tastier – fresh salads and chicken without hormones make all the difference.

On the people:

What impressed us most were the friendly people.

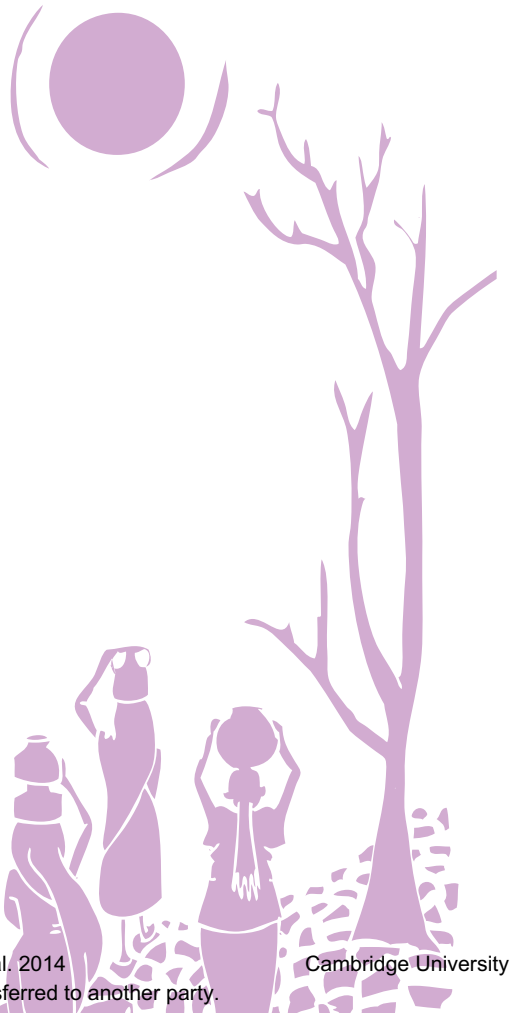
The only negatives were the high prices and the short store hours. But we certainly agree with the Global Liveability Surveys. Melbourne, take a bow!

Geographical fact

The city of Vancouver in Canada lost its title of most liveable city because of traffic jams on Vancouver Island, and it may fall further down the list because of the Stanley Cup riot of June 2011.

The trend towards urbanisation – the gradual relocation of people into big towns and cities – is occurring in countries all over the world, and has taken on new momentum with the rapid growth of economies in Asia. New patterns of urbanisation that are emerging tell us much about the future course of economic activity in the world, including the shifts in the global distribution of power and wealth. *The Global Cities Index* (GCI) released in 2008, 2010 and 2012 assessed these urbanisation trends against 5 key indicators: Business Activity, Human Capital, Information Exchange, Cultural Experience and Political Engagement (according to the 2013 report of A T Kearney, a global management consulting firm). The report also evaluated each city's future **geopolitical power** – its political importance and influence in the surrounding region, based on urban connections or close alliances between cities. This means that a city's geographical location, combined with its historical connections, sources of wealth, cultural beliefs and political leadership, produces influences over large areas or nations that are not always local. These regions are worth considering for improving our understanding of this urban growth phenomenon. The following case study illustrates A T Kearney's analysis.

geopolitical power the political influence exerted by a place on the surrounding region



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Case study 9.1

Excerpt from A T Kearney's report, *The Global Cities Index*

- Washington, New York and Chicago. These cities are becoming more important geopolitically than the United States is as a country.
- Beijing, Hong Kong and Shanghai. Beijing is the centre of power, but Hong Kong's geopolitical role is critical; Shanghai is above all the leading national industrial and financial centre.
- Berlin and Frankfurt. Berlin and Frankfurt time and again emerge as the bulwark for the European Union (EU). If not for the EU, these cities would not be as significant geopolitically.
- Istanbul and Ankara. Istanbul has long been described as the hinge between West and East, with a rich imperial culture and deep knowledge about how to govern such intersections. In combination with Ankara, it is rapidly becoming a major global policy [centre].
- Sao Paulo, Rio de Janeiro and Brasilia. These cities form the new politico-economic heavyweight axis next to now-established China. Brazil's development bank is richer than the World Bank, and its economic power is large and [growing].
- Cairo and Beirut. These cities rearticulate what [West Asia] means as a region. Beirut has long and well-established politico-economic networks worldwide; Cairo has the multitudes and a history of empire.
- Geneva, Vienna and Nairobi. Finally, a step into what has not yet happened but might arrive sooner than we expect: a global environmental and social agenda rising from the current economic paralysis and financial excess. These cities have the critical mass and mix of institutions long devoted to social questions and justice for the powerless, with Nairobi's habitat increasingly important in a rapidly urbanising world and a powerful new leadership. All three cities – long overshadowed by global finance and mega-militaries – could emerge as crucial actors in making a global commons, which will be important for the global economy.

Source 9.6 Excerpt from A T Kearney's report, *The Global Cities Index*

1. Locate each of the cities noted in Source 9.6 and identify any connections you believe exist with Australia. These may be through migration or recent arrivals of people to settle in Australia, other historical links locally, trade, holidays, language and culture.
2. Projecting to the future, which of these global city connections is likely to make an impact on what we do in Australia? Justify your response.
3. Create a blog about a big city you know and record your thoughts and concerns. For a useful reference, see the World Bank blog at www.cambridge.edu.au/geography7weblinks.

ISBN 978-1-107-69012-7

'From there to here, from here to there, funny things are everywhere!'

That one blue fish cost a million plus, that one blue fish and all the fuss.

In cities here and cities there, you'd think by now we'd be aware.

That we'd take some care for what is rare. But here's another to make you stare:

Soup can come with a shark's fin; yes, so strange a fin that's mixed right in.

So much money is being spent, just how far can we go, and to what extent?

'Say! What a lot of fish there are.' Yet there they go near and far.

Tuna, sharks and even rhinos too; all sold in a city near you.

Save a fish, save a tiger, save an elephant or two. Here's what a kid could do

Shout 'Oh Mr. Mayor in that great big chair, is your city doing its fair share?'

Source 9.7 *One fish, two fish, red fish, blue fish* by Dan Hoornweg

Australia's cities

Australia's population is highly concentrated into large cities. The populations of Sydney, Melbourne, Brisbane, Perth and Adelaide account for almost 60% of the country's total residents. A further 20% of the population live in cities and nearby towns of close to or more than 100 000 residents. Through accessing data from the Australian Bureau of Statistics, you can monitor these figures and note the daily changes in Australia's total population.

Why is city or urban life so attractive to Australian families? Consider the following as characteristics of cities or large towns you know. Each of these characteristics expands at a local level the elements included in *The Global Cities Index*. We take each indicator and try to understand its meaning for Australian residents. Of course, for people who have experiences of other places, the meanings are open to wider interpretation.

Source 9.8 An iconic view of Sydney Harbour. Sydney is Australia's most populated city, with over 4.5 million residents.

Landscape and liveability

Shelter is fundamental for our survival. Exactly where we choose to live in cities or other places will sometimes be decided for us by the available housing or shelter. However, where choice does exist, there are elements that can make a place more or less liveable, such as landscape. Landscape usually refers to the natural features of our surroundings. Consider the following and judge for yourself which of them are more important:

- gradient – how steep or flat the surface is
- aspect – relationship to the sun; either southerly, easterly, northerly or westerly
- exposure to the major winds – wind and rain
- soil quality – well drained, deep or shallow topsoil, floods easily
- proximity to water frontage – sea or river
- plants and animals – trees, birds, insect and animal life.

A house or apartment view may be a deciding factor in choosing where to live. Other characteristics of landscape include built and cultural elements, which we will look at next.

ACTIVITY 9.2

1. Where is the most expensive housing in your local area?
2. How many of the characteristics listed can be associated with these locations?
3. In what ways is the streetscape attractive?
4. Identity the potential threats to this streetscape.
5. Evaluate your own home according to the above criteria. Identify some of the positives and negatives and compare them with other members of the class.

Social connections and liveability

Humans are social beings. Their basic needs include more than shelter to survive well; community is also important for health and wellbeing. Many local government councils in Australia have Community and Wellbeing plans. These plans are a good starting point for understanding the meaning of social connections locally. For instance, many of these plans refer to the 'pillars' of community and healthy societies. They include factors like healthy living, family life, work and education availability, transport access, housing and safety. Connecting to others in the community and sharing experiences is now made easier through digital communications. Social networks help build community and enable us to live more sustainable lives. Networks sustain our personal wellbeing, but also help us to share information quickly in times of threat, such as from natural disasters. Engaging with your local council on projects can be a great way to build social connections within your community and better understand the issues that people regard as important for their lifestyles.

Source 9.9 Social interactions through digital communications technologies are allowing people in communities to stay connected with each other.

ISBN 978-1-107-69012-7

ACTIVITY 9.3

1. List some of the social connections you have in your local community. For example, do you engage in any volunteer activities or sports? How are these activities organised and how do they involve members of the community?
2. Identify your local community spaces, including sports grounds, parks and buildings. *Extension:* plan a local community 'event' and create invitations for residents to attend.
3. Use the internet to locate an example of an online community group in your area. What sorts of activities or events does this group participate in? What kinds of people does it attract?

Health and safety

Part of the social landscape is making our places safe. To live well, we all need access to basic services that ensure our survival. Next to shelter, our principal needs are food and water. Ensuring their safe delivery to our neighbourhoods is a major management task for the survival of large communities. Big city concentrations rely on delivery of clean water to our homes and quality food to nearby supermarkets and shops. Achieving these basic needs for our healthy lifestyles requires careful monitoring and the highest standards of scrutiny at every stage in the delivery process. Monitoring our food sources, or **biosecurity**, is a major issue for our city lifestyle. Biosecurity includes all the tests related to hygiene, screening of process factories, packaging and handling of goods between points of origin or production and sale.

biosecurity the protection of humans, other animals and plants against diseases or other harmful biological agents

Local government has a major role to play in maintaining our healthy neighbourhood environments. A visit to the local or shire council website in your area will provide a rich resource for class activities associated with healthy living and safety. Strict regulations related to land and waste management (including household waste and sewerage), as well as sources of pollution and irritation from noise, air and traffic, are all monitored for our collective safe living. Building environmentally friendly neighbourhoods is a standard for Australian communities.

ACTIVITY 9.4

1. Identify qualities that would contribute to a neighbourhood being 'environmentally friendly'.
2. How well does your neighbourhood meet these standards? Suggest some potential improvements that could be made.
3. Check the source of your local water supply and find out where your entire daily food intake comes from. Mapping these food and water chains should demonstrate how complicated city life has become and how much the liveability of urban areas is dependent on the vigilance of governments, community authorities and the integrity of workers supplying our basic needs.

ISBN 978-1-107-69012-7

Source 9.10 Proper hygiene procedures in food processing are vital to community wellbeing.

Infrastructure

Alongside local government efforts to ensure a healthy water and food supply, state and federal governments are responsible for the major elements of our infrastructure needs. These include roads, rail, air and sea connections; schools and hospitals; utilities like electricity, gas and water; and communications services such as Australia Post. Depending on where you live there may be few options available for access to local services. These will become critical considerations related to liveability if, say, the place is located in or near a wooded area where fire is a danger or where there is reliance on outside food deliveries for survival.

ACTIVITY 9.5

1. What transport networks pass through where you live? How could these be improved?
2. How is household waste managed in your community? Is there recycling?
3. Identify some of the other examples of major infrastructure in your area. Examples could include health facilities, such as hospitals, doctors' clinics and ambulance services.

RESEARCH 9.1

Using the internet or a newspaper, analyse the local advertisements for houses and businesses for sale. Take note of the details mentioned in the advertisements; for example, proximity to schools, services and good roads as well as passing traffic for commercial sites are often listed. This should provide you with a collection of terms that are used to describe highly liveable places. Present your findings in the form of a poster. Alternatively, write your own advertisement for a fictitious house or commercial property. Be sure to mention some of the liveability concepts covered in this chapter.

ISBN 978-1-107-69012-7

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Recreation and leisure activities

Once our shelter, food and basic needs for survival are met – for most of us this will be from the financial rewards of paid work – our social needs are likely to motivate us to seek out relaxation time. Recreation and leisure activities are likely to be motivated by personal choice and the availability of services. This is another interesting question to ask of grandparents or older residents in your area: what did they do for leisure that is different from what you and your friends like to do in your spare time? Playing and attending sporting events are an important pastime for many Australian residents, as is playing computer or video games at homes with friends. Other activities include going to cinemas and entertainment centres, or the zoo and botanical gardens, as well as cafés, restaurants, theatres and museums.

Arts and cultural landscape

Depending on where you live, arts and culture may contribute to the appeal of a place. For example, is your town or city famous for any annual event? Perhaps the following are part of the annual calendar of arts and cultural activities:

- rock, jazz, country music festival (for example, Tamworth Country Music Festival, Parkes Elvis Festival, Port Fairy Folk Festival)
- agricultural show
- horse racing (e.g. the Melbourne Cup)
- food tasting festivals and farmers' markets
- busking and street performers
- museums and art galleries
- street markets (e.g. Southbank in Brisbane, Fremantle Market in Fremantle, Salamanca Market in Hobart, St Kilda and Southbank markets in Melbourne)
- annual parades (e.g. Anzac Parade; Australia Day; tulip festivals and other flower or botanical exhibits; street parades for sporting events).

Source 9.11 The Gabba, a major venue for sporting events in Brisbane

ACTIVITY 9.6

1. List all the leisure and recreation facilities available within your local area.
2. Identify the facilities you and your family use and the frequency of their use.
3. Where are these located relative to your home? Which are furthest from home? Why are they getting harder to find?
4. Locate the answers you gave to Question 2 on a map. What do you observe in the distribution?

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Streetscape and liveability

streetscapes views of streets, including the road, connecting buildings, trees and open spaces

Cities are instantly recognisable by their unique buildings and **streetscapes**. To illustrate this point, link each of the following to its city of origin:

- Opera House
- Luna Park
- Fremantle Gaol
- Queen Victoria Market
- Pitt Street Mall
- Anzac Parade
- Salamanca Market
- Bondi Beach
- Glenelg.

Source 9.12 Streetscapes of Melbourne

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Many of these iconic features of our big cities are associated with our heritage and connections to earlier times. For instance, during the early European settlement of Australia, the streetscapes were largely shaped to look like the more familiar scenes to be found in Britain. The early settlers cleared large areas of the native trees and planted the more familiar trees of their native landscapes and European cities. These introduced species of trees included oaks, elms, plane, pines and linden trees. Unlike most native Australian trees, which maintain their leaves all year round, these introduced species are deciduous: they lose their leaves in the winter to avoid damage from the cold chills and snow.

Many streetscapes of the inner suburbs of the bigger cities impart a Parisian and or Mediterranean quality to the lifestyle of residents and visitors that dates back to the nineteenth century. However, the period following World War II brought new immigrants, and a growing awareness of the need to conserve the landscape and, its natural habitats. Newer suburbs, located progressively further away from the central business districts of the major cities, have strict controls for the preservation of the trees and management of their environments. Source 9.12 provides a series of photographs of famous streetscapes dotted throughout Melbourne. They are arranged so as their to show distance from the city centre. Notice the changing landscape of the trees as well as the transport forms, buildings and architectural styles.

RESEARCH 9.2

In your local area, collect images of streetscapes that appeal to you. Identify the aspects of the streets that you like as well as the features that are least appealing. Present these to the rest of your class in an online presentation using PowerPoint, Prezi or a short video. Here are some things to consider for your research: how do you explain the attractive elements in these streetscapes? Why are you attracted to some features and not others? Do the attractive features have links with your family history or birthplace?

9.3 Measuring liveable aspects that are not visible

One of the more difficult elements in measuring liveability is the connections history and geography have with our sense of belonging. For example, Aboriginal and/or Torres Strait Islander people in your local area will have a very specific connection to their land. A sense of belonging is not always easy to define but may have elements best described by the people who call a place 'home'. Sometimes a sense of belonging can be so powerful that it is not easy to describe in words. It just 'is'! This is a subjective feeling that sometimes creates strong emotions within us. If the memories associated with the place are good, then these are likely to be feelings of contentment and happiness. Nowhere is this feeling more acute than when we come back to a place after a long time away; the sense of having 'arrived home' can be part of this. It can be very powerful and a significant source of motivation when people decide where to live and the kind of place they seek to create for their home. For Indigenous people this will always be the place of ancestors and relatives who have passed away, but who live on through the land and its life forces. For families and residents who move into a location or suburb within a larger city or town, a sense of belonging may build up over time. Going to the same school and playing on the same sports team as well as shopping at the same place, holidaying at the same beach and the many rituals of returning to the same places can all add to that sense of a liveable place, and a place we like to call home.

ISBN 978-1-107-69012-7

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ACTIVITY 9.7

1. Think of the places where you feel happiest. List as many words as you can think of that you associate with these places.
2. Next, try to prioritise these into a list. How does your list compare with those of the other members of the class?
3. Express your feelings for your favourite places through a drawing, poem, photograph or piece of music.

9.4 What all places have in common

Having viewed the many ways we can think about the liveability of a place, you should now have a sense of what it is that gives people their sense of wellbeing and contentment with everyday life. More than a building or street or particular location, there is likely to be a complex mixture of elements that make a place liveable. While the actual physical location may differ, there are features of a liveable place that most people would agree are important. Getting a sense of the liveable features of a place can be easier once you build up your knowledge and awareness of the criteria. In the sections you have worked through in this chapter there are lists of characteristics and themes explored, all of which help to build a profile of highly liveable places. The final part of this process is to test your knowledge and application of the ideas through fieldwork in your local area. Two suggested approaches follow; one relates to living in a large city suburb and the other to life in a small town.

FIELDWORK 9.1 CITYSCAPES AND REGIONAL TOWNS

A Exploring the cityscape

Take a map of your local city or town and conduct a photographic cross-section from the centre to the outskirts. Include examples of streets, buildings, parks and recreational places, such as churches and sporting facilities. What are the most observable features of changes that occur as you move further away from the centre? Why? The following example applies to Melbourne, which is a city with more than 4 million residents. You could translate the same approach to a city near where you live.

Aim

To analyse the impact of growth over time and gain an appreciation of concepts related to population distribution and density, and service availability.

Method

Discuss the features of the most attractive places to live and work and how their highly attractive qualities may affect property demand and costs of land. What does it mean to be 'at the centre' in a city? Is this the most desirable part of the city? What evidence will support this conclusion? Does this also make the centre the most liveable location in the city? What different criteria may be needed to support its claim to the the most liveable place?

Preparation

Find a map of the Melbourne and indicate the areas that will be visited and studied. You should include 1 inner-city focus as well as 1 middle-distance suburb, preferably 1 outside the tram route towards the city fringe. You will also need to take a camera, a list of questions based on the 'data collection' section below, paper (in a clipboard) and a pen.

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Data collection

1 At each stop you should record the following information.

   a During a 15-minute session, count the number of pedestrians who walk pass you at a designated location located on your map. Repeat for passing cars, buses and trucks.

   b Photograph what appear to be the main features of the area.

   c Make a list of at least 10 business or non-residential activities.

   d Note the residences, including the types of dwellings. Are they private houses, town-houses and/or apartments?

   e Note down your view of the location and the likely changes that may occur at this site in the next 10 years.

2 What evidence is there of environmentally friendly features, such as green space, recycling facilities, shaded areas for pedestrians and buildings? Note any examples of bad practice.

3 Sketch examples of features that seem to typify the location.

4 How would you describe the people you observe in terms of gender, age, occupation, dress?

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map
Page 3	Introduction – brief description of the study sites
Page 4	Table of traffic flows. Analysis of findings.
Pages 5 and 6	Description of land use, sketches and/or photographs including businesses and residences. Analysis of differences recorded on each site. A point to consider is how often you and your family or friends would normally visit this or similar places. Can you explain the differences in frequency of use?
Pages 7 and 8	Description of observed environmental management strategies including support photographs and sketches
Page 9	Evaluation of the differences and predictions for the future of these places 10 years from now. Conclusion.
Page 10	References

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B Exploring a small regional town

According to the Australian Bureau of Statistics 2011 census data, Westbury in northern Tasmania has a population of approximately 2000 residents. Nearby is the large regional town of Launceston, which has an airport and a university. The photographs in Source 9.13 provide illustrations of the activities found in settlements of this size.

Aim

To identify the features of a small regional town that make it an attractive place to live.

Method

If you live in a small town, make a list of the features you think make it special for you and your family. Try to make a list of the advantages and disadvantages of small town living.

Source 9.13 Images of Westbury, a small Australian regional town located in northern Tasmania

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Next, prepare a collage of digital images and sketches of 10 of the features of the town their most appeal to you. Once you have these, attach the images to a local map and build connections between each place with threads of different colours to indicate the nature of the links. Links can be classified as:

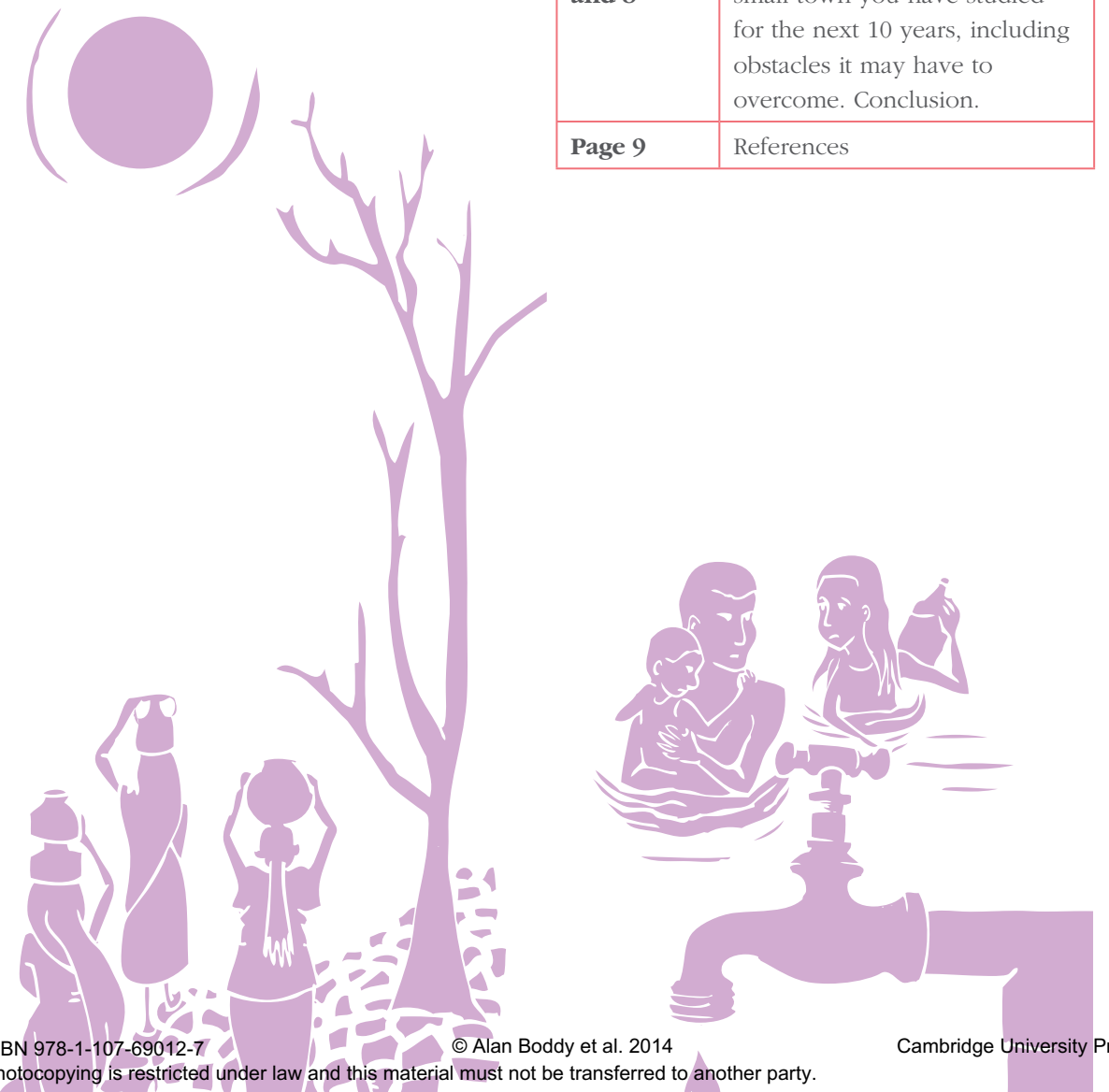
1 business, commerce and other forms of employment
2 social
3 cultural
4 educational
5 services.

What patterns do you observe through these connections?

To what extent are the links local to the town? Which of the links have connections outside the town? Where and why?

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map
Page 3	Introduction – brief description of the study town
Page 4	Your digital photographic collection, including map and connections indicated by coloured threads to sort the links
Pages 5 and 6	Description of life in the town and what makes it attractive to you and special for visitors.
Pages 7 and 8	Evaluation of the future of the small town you have studied for the next 10 years, including obstacles it may have to overcome. Conclusion.
Page 9	References



ISBN 978-1-107-69012-7 Cambridge University Press

Chapter summary

- What makes a place highly liveable depends on characteristics that can be defined as physical, historical, economic, cultural and social.
- 'Liveability' relates to the quality of everyday living as well as sentiments people build up about a place over long periods of time.
- Attachment to a particular place can be due to its geographical location close to work, schools, shops, sports and recreation grounds as well as proximity to public transport and good roads. More likely, though, it will be due to a combination of factors that are personal as well as practical.
- Our sense of place or what makes a place highly liveable is complex and needs an open mind for study and understanding.

End-of-chapter questions

Multiple choice

1 Myths about what makes a place highly liveable do not include which of the following?

A Living near the sea
B Low income
C Access to urban transport
D Clean air and water

2 Highly liveable places are always located near which of the following?

A The sea
B A major road system
C A major shopping centre
D Factories

3 Big cities are highly liveable because they provide which of the following?

A Access to public transport
B Parks and playgrounds
C Cafés and restaurants
D Quiet and tranquil spaces

4 The most liveable places are where?

A Near animals and birdlife
B Close to family and friends
C Where there is very little traffic noise
D Where pollution levels are low

5 When choosing a highly liveable place, which of the following is least important?

A Trees and shady places
B Theatres and cinemas
C Space
D Privacy

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Short answer

1 Identify which aspects of places are most likely to maintain happiness and wellbeing.

2 Describe the aspects of places that are likely to be the least important for most people.

3 List the most important characteristics of highly liveable places.

4 Suggest 5 ways of making a place more liveable.

5 Deduce the biggest problems faced by all megacities.

Extended response

Looking to the future and the prospect of more and more people living in very large cities, what do you see as the major issues for decision makers to consider? What recommendations would you make for meeting these challenges in your local community?

Source 9.14 Adelaide is also in the top 5 of the world's most liveable cities.

ISBN 978-1-107-69012-7

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10 Enhancing liveability

Source 10.1 Melbourne, Victoria

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Before you start

Main focus

Many strategies are used to enhance the liveability of places for different groups of people.

Why it's relevant to us

Individuals and governments need a coordinated vision to develop strategies that ensure communities become more liveable for people.

Inquiry questions

- What strategies can be used to enhance liveability?
- What are the needs of different groups in a community?
- How do we balance different views of liveability?

Key terms

- Community needs
- Compromise
- Consultation
- Personal needs
- Strategies

Let's begin

People have different needs depending on where they live and who they are. Some places in the world will be starting from a low base. A city that has major pollution or crime problems, for example, will face steep challenges to enhance its standing on the liveability scale. Some places already have plans in place to address their liveability issues. Enhancing liveability is a task that requires a coordinated effort by governments and communities.

ISBN 978-1-107-69012-7

10.1 Strategies to enhance liveability

The United Nations Environmental Program (UNEP) has been at the forefront of action to enhance the liveability of the planet. The UNEP, in conjunction with the Cities Alliance and Local Governments for Sustainability, has developed a template for enhancing cites and a report of cities developing successful outcomes. Today, over 50% of the world's population live in urban areas. Cities can be places of excellence, education, employment and hope. Conversely, cities can also descend into poverty, crime and despair. The UNEP report states:

> A successful city must balance social, economic and environmental needs … A successful city should offer investors security, infrastructure (including water and energy) and efficiency. It should also put the **community needs** of its citizens at the forefront of all its planning activities. A successful city recognises its natural assets, its citizens and its environment, and builds on these to ensure the best possible returns.

community needs necessary conditions for the best role, development or wellbeing of the community

In Melbourne, Australia in 2002, the UNEP issued the 'Melbourne Principles' – a road map to achieving sustainability in cities. This comprised the following 10 principles:

1. Provide a long-term vision for cities based on: sustainability; intergenerational, social, economic and political equity; and their individuality.
2. Achieve long-term economic and social security.
3. Recognise the intrinsic value of biodiversity and natural ecosystems, and protect and restore them.
4. Enable communities to minimise their ecological footprint.
5. Build on the characteristics of ecosystems in the development and nurturing of healthy and sustainable cities.
6. Recognise and build on the distinctive characteristics of cities, including their human and cultural values, history and natural systems.
7. Empower people and foster participation.
8. Expand and enable cooperative networks to work towards a common, sustainable future.
9. Promote sustainable production and consumption, through appropriate use of environmentally sound technologies and effective demand management.
10. Enable continual improvement, based on accountability, transparency and good governance.

ACTIVITY 10.1

1. Identify the positive and negative aspects of living in cities.
2. What makes for a successful city according to the UNEP principles? Explain in your own words.
3. Select a city and give examples of what makes it a successful city.

Geographical fact

The year 2007 marked a watershed moment in human history when, for the first time, half of the world's population were living in cities.

ISBN 978-1-107-69012-7

Cambridge University Press

NOTE THIS DOWN

Copy the table listing strategies to enhance liveability in a city and suggest some of the direct and long-term effects of each strategy.

Environmental actions	Direct effects	Other (long-term) effects
Improved provision of water and sanitation services		
Less crowded, better quality housing		
Avoidance of hazardous land sites for settlements		
Promotion of cleaner household fuels		
Improved provision of solid waste management services		
Support for community action to improve local environment		
Improved public transport		

ISBN 978-1-107-69012-7

Case study 10.1
Bangkok, Thailand

Source 10.2 Bangkok city at twilight

Bangkok is the capital of Thailand, which is located in South-East Asia. The country borders Cambodia, Laos, Malaysia and Burma. The city has a population of 10 million, and a total area of 1570 km^2. The city is struggling to deal with the negative effects of population growth and its impact on the local environment. These 2 key factors are directly affecting the city's 'liveability' status.

subsidence the gradual caving in or sinking of an area of land

The current situation

crematoria places where the bodies of the dead are reduced to ashes by fire, usually as part of a funeral rite

Heavy urban traffic has led to traffic congestion and serious air pollution. Odour and smoke from combustion at **crematoria** have a damaging effect on air quality, and respiratory disease is rising dramatically. Water supply quality is deteriorating and canal water pollution is severe, due in part to untreated wastewater entering this system. Most sectors of the local economy are competing for the same limited supply of water. Other impacts of rapid population growth are noise pollution, garbage, land **subsidence** and the growth of slums.

Strategies to enhance liveability

The Bangkok Metropolitan Administration (BMA) has developed a 10-point plan to address these problems. This plan was developed in consultation with the public. The plan was entitled 'The strategy for a sustainable Bangkok: a safe city with a high quality of life'. The 10 goals are as follows.

ISBN 978-1-107-69012-7

Bangkok's 10-point plan

1. Lead urban economy toward sustainability.
2. Use urban planning to improve quality of life.
3. Reorganise traffic and transport to raise the quality of air.
4. Invest in green urban areas.
5. Make Bangkok a clean city.
6. Focus on good governance in the BMA to meet the challenges of the future.
7. Secure easy access to information in the BMA.
8. Use human resources as a strategic tool in social and economic development.
9. Involve citizens in the development of a better Bangkok.
10. Environment, culture and tourism are top priorities – the plan also aims to combat poverty, the growth of slums, drugs and HIV–AIDS.

1. Suggest as many ways that you can think of to encourage the people of Bangkok to leave their cars at home.
2. Imagine you were in charge of dealing with Bangkok's garbage – the city generates 8500 tonnes of waste per day. List some steps you could take to reduce and manage a growing waste problem.
3. Identify what could be done to make the water supply more clean.
4. Explain why the BMA consulted the people of Bangkok to come up with a 10-point plan.
5. Suggest 4 ways in which Bangkok could reduce its carbon dioxide (CO_2) emissions.

Source 10.3 Bangkok, Thailand, is situated in the northern part of South-East Asia.

ISBN 978-1-107-69012-7

Cambridge University Press

Case study 10.2
Cape Town, South Africa

Source 10.4 Cape Town, South Africa

Cape Town is a major city in the country of South Africa. The population is 3.2 million spread over a land area of 2487 square kilometres. The city has a population density of 1291 people per square kilometre. The gross national income for the city is US$3410 per person, but there is a wide gap between rich and poor.

The current situation

Cape Town has a huge problem with urban sprawl. The demand for water, energy and waste disposal is very high. The demand for electricity already outstrips supply and outages are common. Water supplies are also struggling to meet demand and landfill sites are in short supply. Between 15 and 20% of residents live in slums. Illnesses such as HIV–AIDS and tuberculosis are spreading in the population. Unemployment stands at 19% of the workforce. The city's growth is also threatening many local plant and animal species, and extinction rates are among the world's highest for a city. All these factors combine to reduce the liveability of Cape Town.

Strategies to enhance liveability

Cape Town's local authorities have generally focused on environmental issues as their main priority. Africa's first local authority Energy and Climate Change Strategy was begun in early 2007. The main priority within this framework was to make low-income houses more energy and environmentally efficient. A body called 'Local Action for Biodiversity' was established to try to address the management of fragile ecosystems in and around Cape Town. A Youth Environmental Schools (YES) program was established to teach schoolchildren sound environmental practices.

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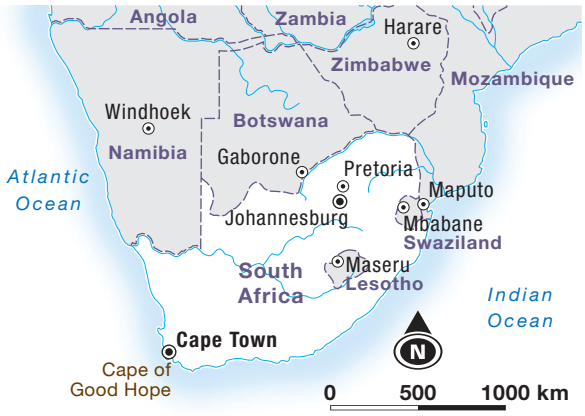

Source 10.5 A map showing Cape Town's position in South Africa

1. Recall the main priorities for Cape Town in its goal to enhance 'liveability'.
2. Identify possible reasons why other problems have a lower priority.
3. Discuss why you think the local authorities introduced the YES program.
4. Suggest ways in which Cape Town could successfully implement an environmental program.
5. Examine why progress to enhance liveability appears to be so slow.

Case study 10.3
Bourgas, Bulgaria

Source 10.6 Bourgas, Bulgaria's fourth-largest city

Bourgas is located on the east coast of Bulgaria in Europe. The city is a coastal port on the Black Sea. Bourgas has a population of 226 000, making it the fourth-largest city in Bulgaria. It has a land area of 48 200 hectares. The gross national income per person was US$2470 in 2005. After decades of former Soviet rule, Bourgas is now looking to the future, and is seeking entry to the European Union to advance its economy.

ISBN 978-1-107-69012-7

Cambridge University Press

The current situation

Bourgas's population is slowly declining due, in part, to young people leaving the country in search of better opportunities, as well as an ageing population and a falling birth rate. The city also has many illegal settlements. On a more positive note, Bourgas has a well-developed health system and a growing tourism market. The city has a strong manufacturing base and a large oil refinery. But the city is paying a price for poor planning, and now has to deal with environmental costs such as high levels of air, water and soil pollution.

Strategies to enhance liveability

Bulgaria's goal of entering the European Union has required the country to put liveability first in its policies. Emphasis has been given to waste management, nature protection, industrial pollution and nuclear safety, as well as local issues. The city introduced its Municipal Strategy for Sustainable Development in 2000. The city made the following investments, upgrades and innovations:

- investments in new public transport to improve air quality
- installation of new water pipes and metres to reduce loss of water
- construction of a new wastewater treatment plant
- improved waste management and to stop illegal landfills
- the 'Greener Bourgas' project (with assistance from the Netherlands)
- involvement in the Liveable Cities project of the European Commission
- air pollution monitoring.

Source 10.7 Bourgas is located on Bulgaria's east coast on the Black Sea.

1 Recall what has motivated the city of Bourgas to take action to enhance liveability standards.
2 Discuss the constraints this city may have faced in its implementation of the program.
3 Suggest how seeking financial assistance beyond the city affects the outcomes.
4 Critically analyse how an ageing population may affect the 'liveability' goals of Bourgas.

RESEARCH 10.1

In August 2012, Melbourne was announced as the world's most liveable city, followed by Vienna, Austria and Vancouver, Canada coming second and third. Research why these cities were selected and prepare a report comparing and contrasting these 3 cities. In your report, consider crime rates, health care, culture, environment, education and infrastructure.

ISBN 978-1-107-69012-7

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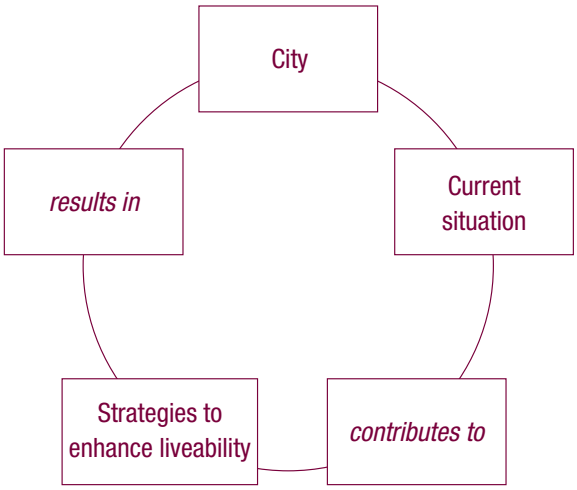
NOTE THIS DOWN

Copy the graphic organiser below and use the information from 1 of the case studies to fill it in.



10.2 Liveability of places for young people

Communities vary enormously in support services available to families to help care for their youth. This variation from community to community is not by chance. Studies have shown that families who have the fewest individual resources live in communities with the fewest shared resources. Low-income young people and youth from a non-English-speaking background are the most affected. Communities with poorly resourced schools often have weak civic and social organisations. As a result, young people often lack adequate opportunities and support where they live, learn, work, socialise and grow. Programs in these areas seem to have minimal impact, but more can be done to help this important group in our community. Young people are involved in and are affected by some of the problems that have a negative impact on communities – drugs, violence, lack of education, unemployment – and they must be part of the solution. Change happens fastest when community programs are able to involve their target audience (young people) and they begin to work together. In order to create opportunities for change, adult change-makers need to focus on shaping policy, improving services and building demand, but more needs to be done. They need to find ways to involve large numbers of youth in their core work. They should make sure that young people are involved not just for the experience but also for the results they are striving to achieve. They should also develop strategies for involving as many young people as they can.

Source 10.8 Young people playing football

ISBN 978-1-107-69012-7

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ACTIVITY 10.2

1 Investigate current youth programs in your area and determine how successful they are.
2 Explain why young people growing up in poorer demographic areas are at a disadvantage.
3 Design a youth program that could help reduce 1 of these problems in society: drugs, road accidents, unemployment or poor attendance rates at school.

RESEARCH 10.2

Select a place in Australia or Europe and research the successful solutions and strategies implemented in order to enhance liveability. Create a poster that compares and applies these strategies to your own local community.

10.3 Diverse needs of groups

Approximately 73% of Australia's population were born in Australia. Between the dates of the 2006 and 2011 Censuses, a total of just under 850 000 permanent migrants settled in Australia. Most migrants to Australia come under the 'skilled migration' stream – their visas are based on their having particular employment skills. The next largest category is family reunion migration (people applying to join family members in Australia).

Source 10.9 Cultural diversity is one of Australia's greatest assets.

Third is the humanitarian stream, which includes Australia's UN-approved refugee intake, and a small number of asylum-seekers arriving by boat or plane and processed through the immigration detention centres. Cultural diversity is one of Australia's greatest assets. There are people here from more than 200 different countries; they speak as many as 270 languages and identify with more than 100 religions. Our cultural diversity and expanding population bring many economic, social and cultural benefits, while also creating challenges to the public sector in providing policies, programs and services that successfully meet the needs of all Australians. In order to build communities that are successful at improving conditions and resolving problems for all, we need to understand many different cultures and develop strong relationships with each other.

Enhancing liveability for different groups

Diverse groups of people and communities have different needs depending on where they live and who they are. It is vital to develop policies and understandings that can be applied to society as a whole. Information should be available and

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public policies should be easy to understand and culturally appropriate. Sometimes this may be difficult because we have such a diverse range of cultures that at times they may contradict each other. However, it is important to be aware of the varying cultures in society and to communicate with this in mind. **Compromises** may need to be made to encourage sectors in the community to begin to work together. Public consultation is an important part of this. A community leader could send out a questionnaire or survey asking the people in that community what they need in order to bring about a better standard of living. A farming community, for example in times of drought, may want to discuss the possibility of a dam being built in their area. A community that has a high percentage of elderly citizens may want better access to health care. **Personal needs** may not seem to be part of the 'big picture', but often they play an important part in an individual's feeling of self-worth. If each group in a community joins forces with the others, they will all be more effective in reaching common goals than if each group operates in isolation. By exchanging information each group gains an understanding of what the community as a whole requires.

compromise an agreement or a settlement of a conflict that is reached by each side making allowances

personal needs needs of an individual rather than of the family or the community

ACTIVITY 10.3

1. Recall how many migrants settled in Australia between 2006 and 2011.
2. Discuss why it is important that Australia recognises migrants as an integral part of our nation.
3. Predict what may happen if a sincere effort is not put forward to bring different cultural groups together.

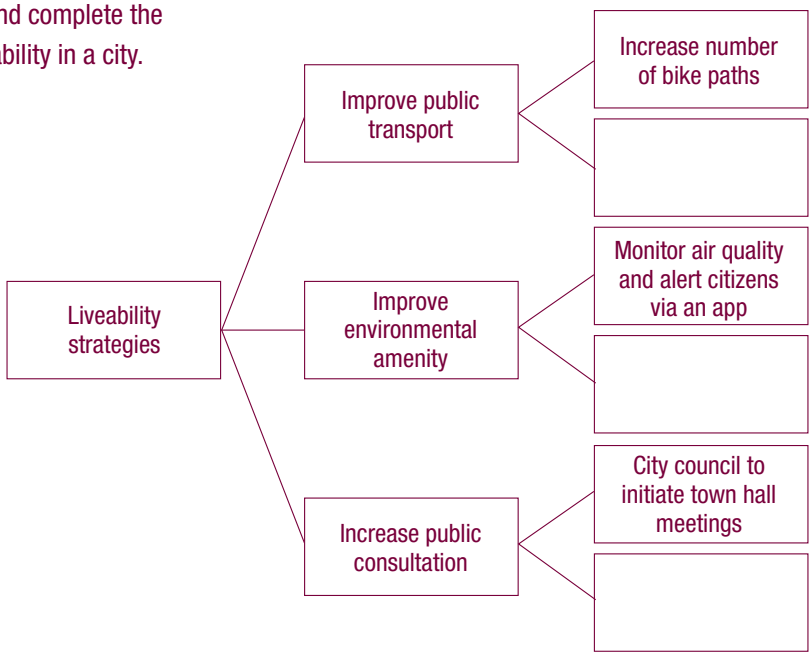
RESEARCH 10.3

Select a country, other than Australia, and research its population breakdown. Create a PowerPoint presentation that includes the percentages of Indigenous and migrant peoples and an analysis of whether the country's multiculturalism has a positive or a negative effect.

ISBN 978-1-107-69012-7

NOTE THIS DOWN

Copy the graphic organiser below and complete the potential strategies to enhance liveability in a city.



ISBN 978-1-107-69012-7

FIELDWORK 10.1 AMENITIES FOR YOUNG PEOPLE

Aim

To analyse how your local community ensures that young people are provided for in terms of transport and recreational spaces and activities. Your local community may be a small town, region, suburb or city.

Method

The whole class can undertake this fieldwork during a couple of periods without leaving the school by using previous visual observations and the internet. Define the borders and parameters of your local community, and identify the transport and recreational options available for young people.

Preparation

On a web mapping application such as Google Maps or Google Earth, locate your community. Draw a rough outline map using the web map image as a guide.

Data collection

Research via the internet what transport options young people have, as well as the recreational locations and activities. Note these down on your map. Use a colour code to mark the following areas on your map: transport routes (with different colours to indicate rail and bus routes), sporting clubs, entertainment complexes and other facilities (e.g. libraries, dance classes, chess groups). Once your fieldwork is complete, you will need to transfer all of your data onto a completed map of preferably A3 size. This map should show BOLTSS (except for scale, which is not essential).

Your map should have a:

Border

Orientation – indicating north

Legend – showing the features on your map including what each area of shading represents

Title – a heading that describes the map and what it is showing

Scale (not essential)

Source – the details where the information used to create the map came from.

Once your fieldwork is complete, write a report on whether your findings indicate that young people are provided for in terms of transport, recreational spaces and activities in your community. Suggest what is required if your conclusion is that they are not provided for. If your conclusion is that they are adequately provided for, comment on the planning and geographical locations of these outlets.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map
Page 3	Introduction – brief description of the study sites
Pages 4 and 5	Description of uses and photos
Page 6	Table of usage: effects of use (positive or negative, short-term or long-term)
Pages 7 and 8	Description of effects of use, sketches and/or photos
Page 9	Association between use and effects of use
Page 10	Table or written description of transport options
Page 11	Table or written description of recreational options
Page 12	Evaluation of these options and conclusion
Page 13	Appendix, bibliography, glossary

ISBN 978-1-107-69012-7

Chapter summary

- Enhancing liveability is a task that requires a coordinated effort by governments and communities.
- The UNEP is encouraging cities to develop a strategic plan to enhance liveability.
- The Melbourne Principles were instituted by the UNEP in Melbourne, 2002. These principles demanded vision, social security, biodiversity, ecological awareness, sustainability, cultural values, empowerment, cooperation, management and improvement. Some cities are clearly doing better than others in meeting these objectives.
- Bangkok, Cape Town and Bourgas are 3 cities attempting to plan for a better future.
- Adult change-makers need to find active ways to involve large numbers of youth in their core work.
- People have different needs depending on where they live and who they are.

End-of-chapter questions

Multiple choice

1 UNEP stands for:
- **A** United National Education Project
- **B** United Nations Environmental Project
- **C** United Nations Environment Program
- **D** United National Environmental Project

2 Bangkok has to address which 'liveability' issue?
- **A** Water pollution
- **B** Garbage disposal
- **C** Air pollution
- **D** All of the above

3 Cape Town's main priority is:
- **A** its environmental program
- **B** landfill purchase
- **C** public transport improvement
- **D** slum clearance

4 Bourgas has had to deal with which problem?
- **A** A lack of community good will
- **B** No foreign financial support
- **C** A declining population
- **D** A growing population

5 The Melbourne Principles were:
- **A** developed by the UNEP
- **B** signed off by UNEP delegates in the city of Melbourne
- **C** demanding vision and action
- **D** all of the above

ISBN 978-1-107-69012-7

Short answer

1 Describe what support can be given to cities that may be struggling to enhance their liveability.

2 Discuss whether a city can meet all its liveability targets at the same time or whether it should focus on a few key improvements.

3 Evaluate this statement: 'Case studies of cities enhancing their liveability are not necessarily transferable to another city'.

4 Do poorer cities in the world have any hope of enhancing their liveability?

5 Which of the 3 cities studied in this chapter – Bangkok, Cape Town and Bourgas – has the best chance of achieving its objectives? Justify your answer.

Extended response

In an essay, debate the following statement, with reference to each of the case studies featured in this chapter: 'Enhancing the liveability of a city is only possible thorough a clear and concerted plan of action. It will not happen just on its own.'

Source 10.10 Cape Town by night

ISBN 978-1-107-69012-7

Cambridge University Press

Glossary

abrasion erosion caused by rocks that are carried along by water

aesthetic relating to the nature and appreciation of beauty

aesthetic values the valuing or appreciation of something due to its beauty

affinity a natural liking for or attraction to a particular person, place or idea

affordability the extent to which a commodity such as housing can be afforded

agriculture the farming of animals and plants (crops)

algal bloom the build-up of algae that can destroy ecosystems

altitude the height of land above sea level

aquatic relating to water e.g. in reference to plants, animals or activities

aqueduct a human-made channel or passage for conveying water

aquifer geological formation containing ground-water that can supply water to wells or springs

arid having a severe lack of rainfall – below 250 mm per year

ashram a community where people (mainly Hindus) practise yoga, meditation and other spiritual activities

atmosphere the gaseous envelope surrounding the Earth; the air

baptism a ceremony purifying the spirit through contact with holy water

bias mindset with a particular interest or view that limits one's ability to make a fair judgement

biodiversity the number and variety of species of plant and animal life within a region

biosecurity the protection of humans, other animals and plants against diseases or other harmful biological agents

biosphere the ecosystem comprising the Earth and all living organisms that inhabit it

blue water freshwater in lakes or rivers

bores holes drilled into the ground to extract groundwater

brackish water water that absorbs salts from the soil but has a lower salt content than seawater

caiman a species of tropical American alligator

catchment (or drainage basin) the total area where water from precipitation collects and drains downhill into a body of water such as a river, lake or ocean

centrality the attractiveness of an urban location in terms of accessibility, functions, facilities and activities

chasm a deep fissure or groove in the Earth's surface, formed by geological processes and water

cholera an infectious disease caused by contaminated water; it causes severe vomiting, cramps and diarrhoea, and can often be fatal

citation full and appropriate referencing of a source

civic planner someone who plans the layout, development and growth of cities and urban areas

climate change a gradual change to the world's normal climate state that may affect the future of the planet

commodity a resource that can be bought and sold

communicable diseases infections and diseases that can be transmitted from one person to another

community a group of people sharing the same locality or similar interest

community needs necessary conditions for the best role, development or wellbeing of the community

compromise an agreement or a settlement of a conflict that is reached by each side making allowances

condensation the process whereby water molecules join together and so change the water from a gaseous to a liquid state

condenses changes from vapour to liquid

conducive favourable, helpful

conservation preserving and restoring resources from loss, damage or neglect

conservationists people who work to protect the natural environment and its living organisms

continuous resources resources that are in no danger of being used in excess of their long-term availability

ISBN 978-1-107-69012-7

Cambridge University Press

convectional rainfall rainfall that is caused when air containing water vapour is drawn upwards due to heating of the Earth's surface (e.g. in tropical regions)

coolamon a basin-like dish made from wood or bark

country the Aboriginal concept of place, which includes all aspects of the environment including life

crematoria places where the bodies of the dead are reduced to ashes by fire, usually as part of a funeral rite

cubic metre the volume of a cube with its edges 1 m in length (equal to 1000 litres)

cultural value the emphasis placed on something for its importance and place in society, such as the inclusion of water in rituals, heritage and the Dreaming

debris the remains of something that has been destroyed or broken up

decentralisation the process by which population and industry move from an urban centre to outlying districts

degradation a reduction in the quality of an environmental resource

delta a generally triangular area of land at the mouth of a river where the river branches out before entering a sea or lake

demographic a group of people defined by a particular shared characteristic

demographic profile a collection of demographic information used to create a description of an average member of the population

depletion a reduction in the quantity of an environmental resource

deposition the laying down of sediments that have been transported by water or wind

desalination plants factories that convert seawater, through a complex scientific process, into fresh drinking water

developing countries poorer countries of the world that are seeking to become more advanced economically and socially

disparity the state of being unequal

distribution the way in which something is shared out among a group or spread over an area

diversion the transporting of water away from a river, normally for the purpose of irrigating farmland

drought a shortage of rainfall over an extended period of time

economic value a dollar amount placed on an asset to show how much it is worth

economic water scarcity a situation in which a place has adequate local supplies to meet its water needs, but lacks money to create the infrastructure for the population to access safe drinking water

economies of scale a fall in average costs resulting from an increase in the scale of production

ecosystem a community of living things, including animals, plants and microorganisms

elevation height above sea level

enclave a small, distinct area or group that is enclosed or isolated within a larger one

environmental relating to the physical environment

environmental conservation preserving and restoring the environment to ensure no further degradation

environmental flow the amount of water required to maintain river health

environmental resources natural resources that have originated directly from the biophysical environment.

environmentalist a person who acts to preserve the quality of the natural environment

Equator the zero degree line of latitude that circles the middle of the Earth

erosion the wearing away of the surface of the Earth by the action of wind and water

estuaries bodies of water formed where freshwater from rivers and streams flows into the ocean, mixing with the seawater

estuarine relating to or found by the tidal mouth of a river

ethnicity a person's racial or cultural background

evaporates changes from liquid to vapour

evaporation the part of the water cycle where water changes from a liquid into a gas and escapes into the atmosphere

ISBN 978-1-107-69012-7

evapotranspiration the process whereby water is released into the atmosphere through evaporation and the transpiration of plants

exodus the departure of a large number of people

expressionist art an art form that uses distorted forms to create intensity and express heightened emotions

fjord a long narrow inlet with steep sides or cliffs created by glacial activity

flood a large overflow of water that drowns areas of land, usually causing extensive damage to those areas

flood peak the highest point that floodwater reaches

flood plain low-lying land along river valleys, lakes and coastlines that is subject to flooding

functions certain purposes or activities that come naturally to a person or object

geography the scientific study of the Earth's surface (and immediately below it), especially the patterns and processes that affect it, such as climate, population, land use and environmental elements

geopolitical power the political influence exerted by a place on the surrounding region

ghats steps leading down to a river

globalisation the process by which the world is becoming more interconnected, with an increase in social and economic integration between countries (e.g. an increase in international trade and communication)

green space an area of grass, trees or other vegetation set apart for recreational purposes in an urban environment

green water moisture in the soil

groundwater water that is located beneath the Earth's surface

hazard a situation that poses a threat to life, health, property or the environment

hydraulic erosion erosion caused by the power of water and gravity

hydroelectric operated by, or production, of hydropower

hydrological hazard a hazard associated with water that has the potential to cause death, loss of possessions and loss of crops leading to famine

hydroponics a method of agriculture in which water and nutrients are applied to plants without the need for soil

hydropower the generation of energy by harnessing the power of water

hydrosphere the water on or surrounding the surface of the globe, including water in the atmosphere

hydrotherapy treatment to manage pain and increase movement of the body via the use of water and gentle exercises while immersed

hypothesis a proposition made on the basis of limited evidence, used as the starting point for further investigation

impressionist art art characterised by short brush strokes of bright colours that tend to blend together smoothly when is viewed at the finished piece from a distance

Indian monsoon seasonal heavy rains that fall in the Himalayan regions of south Asia

industrialisation the modernisation of a country, involving large-scale infrastructure development, economic growth and a movement towards more efficient, mechanised methods of production

infiltration the process by which water on the ground surface soaks into the soil

informed consent permission granted in full knowledge of what is being asked and all consequences

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services and education systems

intertidal zone the area at the edge of a body of water (e.g. the ocean) that is exposed at low tide and under water at high tide

inundate to flood an area

investment spending money on something for a financial reward or return

irrigate to water farmland using water that has been diverted (e.g. by human-made channels) from the river system

irrigation watering of crops

kin the people closest to you related by blood; kinship usually refers to family

ISBN 978-1-107-69012-7

Cambridge University Press

latitude an imaginary line measuring degrees north and south of the Equator

lithosphere the solid portion of the Earth made up of the crust and upper mantle

liveability conditions in a place that make it easy or difficult to live there

longitude an imaginary line measuring degrees east and west of the Prime Meridian (or the Greenwich Meridian)

low pressure system a weather pattern in which atmospheric pressure at sea level is below that of surrounding locations

mangrove tree a type of tree with unique features that enable it to grow in intertidal zones or estuaries

megalopolis a long continuous urban area

Mesopotamia the region around the Tigris and Euphrates rivers – modern-day Iraq

meteorologists people who study weather and climate

monsoon seasonal winds that bring torrential rainfall

multicultural describing a society that reflects and is open to many different cultures

Newstart the system of social welfare payments for financial help provided by the Australian government

noise pollution annoying and unpleasant levels of sounds, such as from aircraft or traffic

non-renewable unable to be naturally replenished and sure to be used up at the human rate of use

non-renewable resources resources that are unable to be naturally replenished and sure to be used up at the human rate of use

orographic rainfall rainfall that is caused when masses of air containing water vapour are forced upwards by physical features such as mountain ranges

patronage customers paying for goods or services

peninsula a piece of land going out into water from a larger land mass

periphery the edge or outskirts

permaculture agricultural systems that are designed to be sustainable and self-sufficient

personal needs needs of an individual rather than of the family or the community

photosynthesis the process by which plants convert solar energy and carbon dioxide into glucose and oxygen

physical water scarcity a situation in which a place lacks local supplies of water to sustain current standards of living

population density the number of people that live within a defined area, such as a square kilometre

precipitation water that falls from clouds and may be in the form of rain, hail, snow or sleet

primary source information that comes directly from the event or area we are studying. It is 'first hand' and we use it to classify most of the data collected during fieldwork

public servant a person who holds a government position by election or appointment

public transport a form of transport that can be used by any member of the public, whether free of charge or for a fee

quantitative methods methods used to gather data that are expressed in numerical form

qualitative methods methods used to gather data that are expressed in non-numerical form (and therefore can only be described)

recreational value the emphasis people place on something in terms of its leisure purposes and enjoyment

remoteness distance, a very distant situation

renewable able to be naturally replenished and sure not be completely used up at the rate of human use

renewable resources resources that can be replenished in a relatively short amount of time through reproduction or other biophysical processes

respiration inhalation and exhalation of air by humans and animals; breathing

reticulated sewerage the system of pipes and drains that takes raw sewage from a dwelling to a sewage treatment plant, removing the need for open channels that smell and are unhygienic

ISBN 978-1-107-69012-7

Cambridge University Press

riparian relating to the banks of or near a river

river mouth the end of the river system where water exits into a sea or lake

river regulation the building of dams and other structures so that people can regulate (control) the flow of water through the river system

rolling stock trains or other vehicles used on a railway line

run-off water (from precipitation) that flows over the land and collects in rivers, lakes, seas and oceans

saline having high levels of salt

salinity the salt content of water

saltwater describing a group of Indigenous people from the north of Australia in an area marked by coastal and marine environments including mangroves and coral reefs

sanitation the provision of adequate facilities such as toilets, and services such as garbage collection, to promote community health and hygiene

sea changers colloquial term for people who opt for what they perceive as an improved quality of life by the coast

seascape a view of the sea

secondary source information that is put together by someone not directly involved in the event or area that we are investigating

sediment material eroded from the land and river banks by water and deposited elsewhere

self-determination the essential right of all people to freely decide their own political status and to freely pursue their own cultural, economic and social development

semiconductor a device – usually containing silicon – which conducts electricity. Semiconductors are commonly very small and can be found in thousands of products such as computers, phones, appliances and medical equipment.

semi-detached houses two houses that are joined by a shared wall

settlement a settled community

settlement hierarchy an ordering of settlements by their size and population. Settlements at the top of the hierarchy, such as large cities, are few in number but hold more status, power and influence. Settlements further down the hierarchy are smaller in size and influence, but greater in number.

severe storms storms, including thunderstorms and cyclones, that cause serious damage to the country

shaduf a device used in Egypt and other Eastern countries for raising water, especially for irrigation, consisting of a long suspended rod with a bucket at one end and a weight at the other

silt small particles of soil and rock that are carried along by the force of rushing water and deposited in areas of still water

social activist a person involved in a campaign to promote change, stop change or direct change associated with social issues and policy

socio-cultural relating to both society and culture

specialisation of labour labour where the workers spend time in only 1 area of work

sphere of influence an area over which a place has influence; how far people are willing to travel for a particular service

storm surge ocean water that is pushed onto land by the effects of a severe storm or cyclone

streetscapes views of streets, including the road, connecting buildings, trees and open spaces

subculture a group of people who share characteristics that are different from those of the rest of society

subsidence the gradual caving in or sinking of an area of land

sustainability the wise use of resources so they are available indefinitely into the future. Society, environment and economy must all be carefully considered.

tectonic plates the giant irregular slabs that break up the Earth's crust; they move and cause volcanoes and earthquakes, as well as the formation of mountains, rift valleys and oceanic trenches

telecommuting working at home by using a computer that is electronically linked to your place of employment

terra nullius land belonging to no one

ISBN 978-1-107-69012-7

terrace farming a farming method in which a series of steps (terraces) are levelled on the side of a hill or mountain for agricultural production

terraces rows of houses that share their sidewalls with the adjacent houses

topography the shape of the land

transpiration the process by which plants lose water to the atmosphere

transpire to absorb and release heat as water evaporates from plant leaves or animal skin (thereby cooling the plant or animal)

transportation the process of moving along sediments (rock materials and soil) by water or wind

tree changers colloquial term for people who opt for a perceived improved quality of life by moving to the countryside

tributaries smaller rivers that flow into larger rivers

tributary a river or stream flowing into a larger river or lake

tropical cyclones storms that form over the ocean as a result of warm waves, clouds and low air pressure

troposphere the atmospheric layer closest to the ground, containing 99% of the atmosphere's water vapour

tsunami an ocean wave, sometimes large, caused by an undersea earthquake, volcano, landslide or other disturbance

urban consolidation building up existing urban areas rather than moving people to the edges of the city

urban sprawl the growth of housing on the edge of a city

urbanisation the process whereby more and more people are coming to live in towns and cities

urbanised having a higher proportion of people living in towns and cities than in rural areas

water cycle the continuous cycling of water through the Earth's spheres via processes of evaporation, condensation, precipitation, run-off and infiltration

water scarcity a situation in which there is insufficient water to maintain current standards of living

weathering the loosening of rocks by chemical or physical processes

wetland environment an area of land that is saturated with water, either permanently or periodically. It is an important ecosystem with a unique set of animals and plants.

wharf a human-made landing place for ships on a shore

woomera a notched stick used to propel spears or darts

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