

RIVERINE ENVIRONMENTS: PROCESSES, CHANGE and MANAGEMENT Part 1



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Education Consultant
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GTANSW
Annual Conference
2017

<https://www.usgs.gov/media/video/s/effects-urbanization-stream-ecosystems-extended-part-i-introduction>

An OPTIONAL STUDY

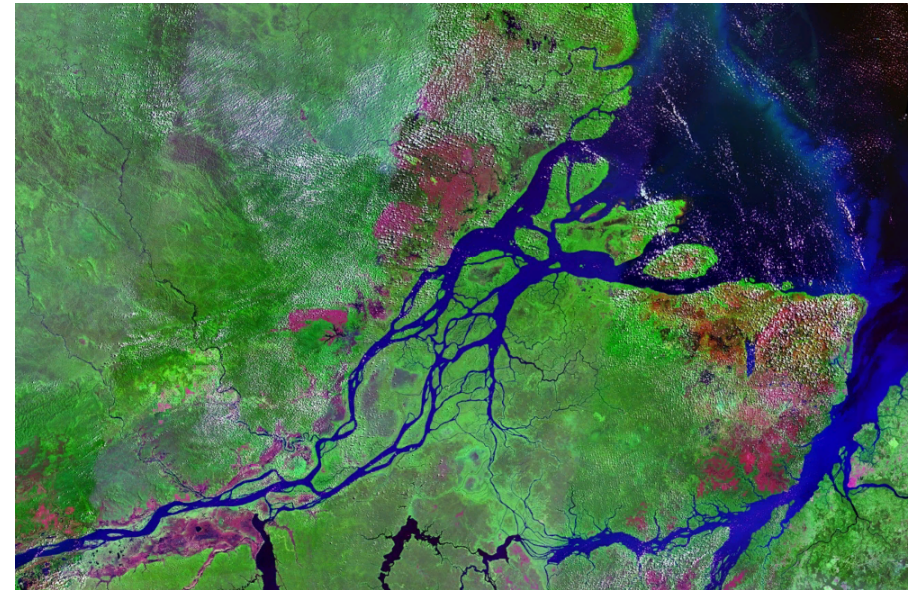
Environmental change

Riverine environments offer a wide range of contemporary issues for study

The management of issues in riverine environments necessitates an understanding the processes and functioning of riverine environments in different places

There are plentiful and contemporary resources to support this optional study

This is not a study of riverine landforms – it is an investigation of changing the living environment of rivers and their associated environments



https://upload.wikimedia.org/wikipedia/commons/6/6f/Mouths_of_amazon_geocover_1990.png

Environmental change and management

“The World Rivers Review in 2011 claimed “ *Earth’s rivers are dying from a thousand cuts*”, a reference to human impact on the environmental processes essential for healthy river functioning.

Declining river health is reflected in high extinction rates for freshwater biodiversity, up to six times higher than for marine and terrestrial ecosystems. An estimated 20% of total freshwater species are endangered or extinct.

Only 64 of Earth’s 177 longest rivers (over 1000 km) remain unregulated and just 21 still flow to the sea, evidence of unsustainable water use. Sound ecological knowledge is essential for the sustainable management of riverine environments.”

Source: [GeoWorld 10 NSW](#) Chapter 5: Inland water: processes, change, management

First some GEOSTORIES

Worldviews are changing

New Zealand – legal status of rivers

The Netherlands – Flood management

USA – dam removal

Asia & South America – Dams vs
biodiversity

Australia – environmental & cultural
flows, river restoration



http://www.dailymail.co.uk/travel/travel_news/article-3471121/Nature-s-masterpiece-Incredible-images-reveal-stunning-beauty-braided-rivers-look-like-inky-watercolour-paintings.html

In 2016 in New Zealand

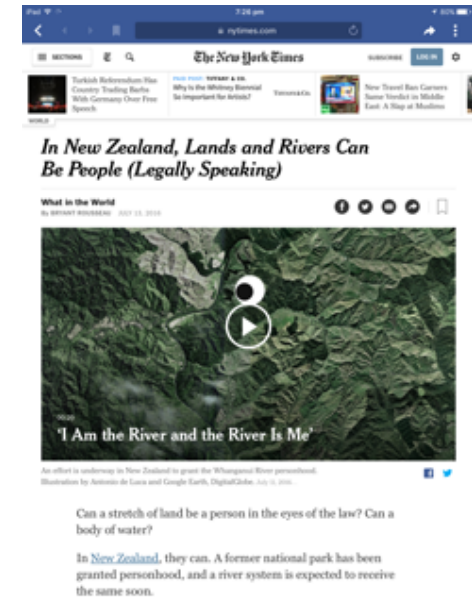
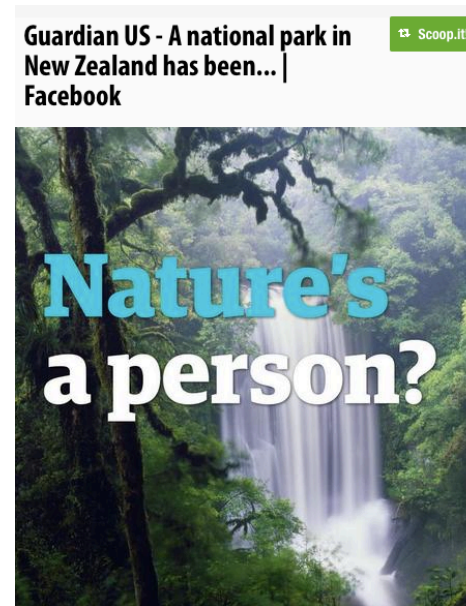
RIVERS HAVE LEGAL STATUS ...

AT THE SAME TIME A BLAME GAME TAKING PLACE OVER WHO IS RESPONSIBLE FOR THE DECLINING QUALITY OF NZ RIVERS

(Comparative study)

Maori worldview ...

Are worldviews changing globally ?



[SEE Loraine's Scoop.it Environmental Change for articles and video links related to NZ](http://www.scoop.it/t/year-10-environmental-change-and-management)
<http://www.scoop.it/t/year-10-environmental-change-and-management>

Why New Zealand is granting a river the same rights as a citizen

Tuesday 6 September 2016 2:53PM

Kathleen Calderwood



IMAGE: THE WHANGANUI RIVER ON NEW ZEALAND'S NORTH ISLAND WILL SOON BE GIVEN LEGAL PERSONHOOD. (FLICKR/KATHRIN AND STEFAN MARKS/CC BY-NC-ND 2.0)

The New Zealand government is planning on giving the country's third largest river the same rights as a citizen. It's part of a legal revolution recognising the Maori connection to the environment and shifting assumptions about human control of the natural world.

They are recognised in law now as having their own presence, their own needs and their own well being.

PROFESSOR JACINTA RURU, UNIVERSITY OF OTAGO

Until 2014, Te Urewera in the Hawkes Bay region of New Zealand's North Island was a national park.

The Act removed the land's national park status and granted it legal personhood, giving it the same rights as any citizen.

<http://www.abc.net.au/radionational/programs/sundayextra/new-zealand-granting-rivers-and-forests-same-rights-as-citizens/7816456>

New Zealand – Comparative study

See the Word Document summarising this recent media series and images from the articles in resources attached to this PPT on the GTANSW Website.

Scooped by Lorraine Chaffer

Special report: The blame game over NZ river health



From www.newshub.co.nz - March 3, 7:08 AM

"In part four of our investigation into NZ rivers we look at who is really responsible for their decline."

Scooped by Lorraine Chaffer

Special report: how polluted are New Zealand's rivers?



From www.newshub.co.nz - March 2, 9:24 AM

"Who is really to blame - and what's being done to save the worrying state of NZ's rivers?"

Scooped by Lorraine Chaffer

Special report: Will climate change kill off NZ's rivers?



From www.newshub.co.nz - March 2, 9:18 AM

"Part three of our investigation into NZ river health looks at whether we've already reached the tipping point."

Special investigation: What is being done to save New Zealand's rivers?



From www.newshub.co.nz - March 2, 9:23 AM

"Part two: The dairy industry responds to criticism its farmers are destroying Kiwi rivers."

<http://www.newshub.co.nz/home/new-zealand/2017/03/special-report-will-climate-change-kill-off-nz-s-rivers.html>

New Zealand Selected images from the series

What is Polluting New Zealand's Rivers? Sediment

Rain falls onto deforested land

The rainfall spills sediment into waterways

The sediment forms a mat over the riverbed, cutting off life

The Scale of Deforestation in New Zealand

1000AD
Native forest before human arrival

2017
Native forest

What is Polluting New Zealand's Rivers? Nitrogen

Cows urinate into the soil

Nitrogen from the urine travels through the soil into waterways

The nitrogen can create toxic algae and choke the water of oxygen

What is being done to protect New Zealand's rivers?

Fencing waterways from livestock

Riparian planting to protect waterways from nitrogen

Riparian planting protects waterways from further sediment gain

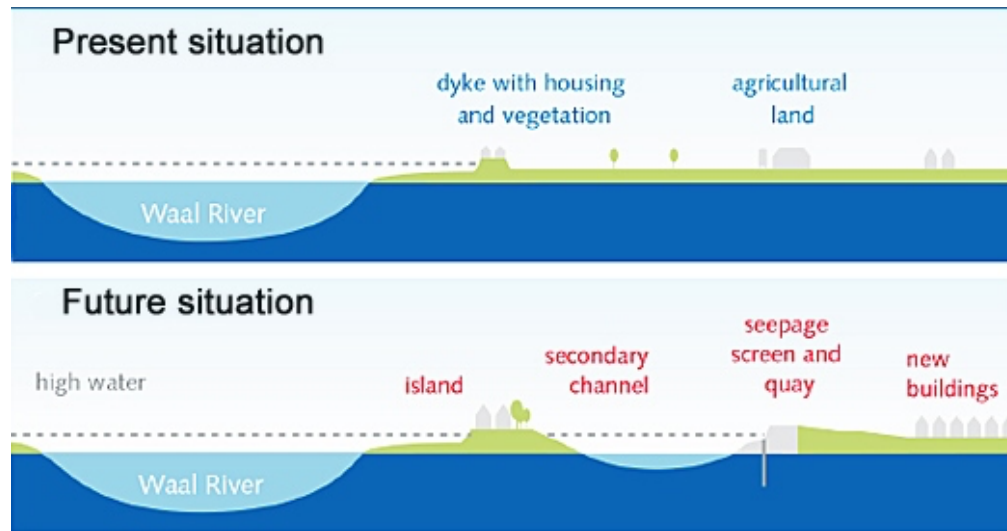
Riparian plants help shade waterways to keep them cool

<http://www.newshub.co.nz/home/new-zealand/2017/03/special-report-will-climate-change-kill-off-nz-s-rivers.html>

In the Netherlands.....

After thousands of years of building hard structures to protect property from floods, particularly in the Spring snow thaw season, the Dutch government have implemented a Room for the River program, that gives the river back the space it needs to floodan initiative that reconnects a river with its floodplain

Why the change?



<http://www.dutchwatersector.com/news-events/news/4986-groundbreaking-ceremony-biggest-room-for-the-river-project-a-3-km-long-side-channel.html>

<https://www.royalhaskoningdhv.com/en-gb/projects/room-for-river-waal-dike-relocation-lent-nijmegen/945>

NIJMEGEN

A Dutch city makes room for its river — and a new identity

LETTY REIMERINK MAY 14, 2015



The Dutch city of Nijmegen is building a flood-control channel for the River Waal (left). In the process, it is also creating an island for recreation as well as prime property that can be developed into a new heart of the city. (Room for the River Waal)

Flooding is a natural riverine process ... Management depends on understanding natural processes and human change to those processes.

<http://citiscopes.org/story/2015/dutch-city-makes-room-its-river-and-new-identity>

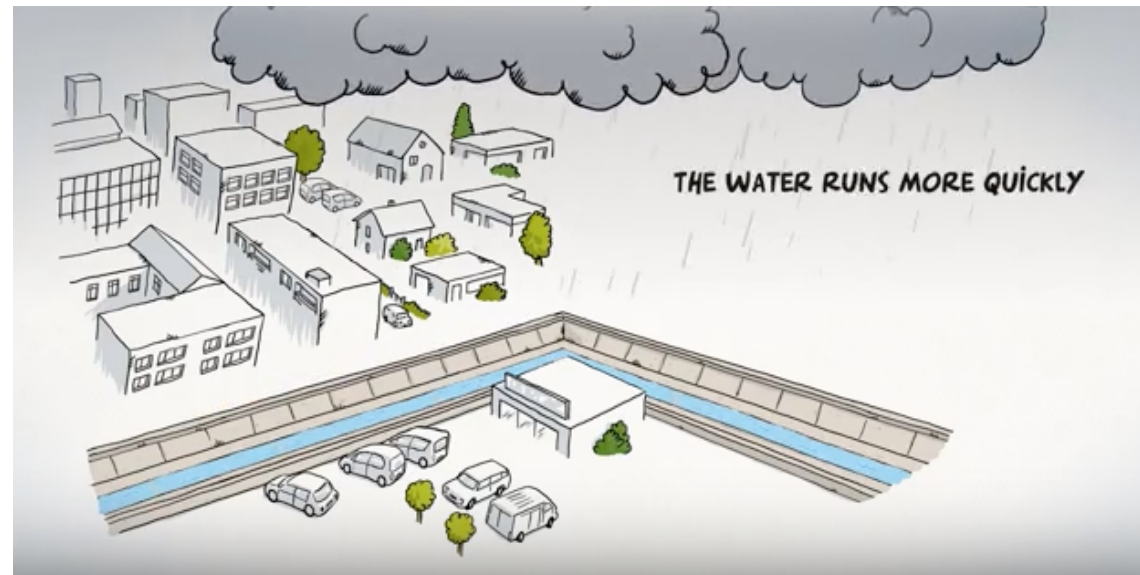
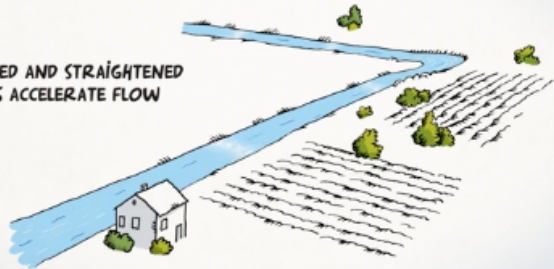
River management change ...animation

https://www.youtube.com/watch?v=21YAP8RF_sw&sns=em

A new type of river management is coming!

Scoop.it!

MODIFIED AND STRAIGHTENED RIVERS ACCELERATE FLOW



In Brazil... anti dam protests



More than 400 hydroelectric dams are already in operation, being built or planned for the Amazon basin and its headwaters.

Protesters say the 6km Belo Monte dam will threaten the survival of a number of indigenous groups and could make some 50,000 people homeless, as 500 sq km (190 sq miles) of land would be flooded.

<http://www.bbc.com/news/world-latin-america-12399817>

https://www.google.com.au/search?q=room+for+the+river&source=lnms&tbn=isch&sa=X&ved=0ahUKewj96MvX8tXSAhUBS7wKHb_gAaMQ_AUIBigB&biw=1297&bih=1252#tbn=isch&q=Belo+MOnTe+dam+Brazil+protests&*&imgcr=pN-TeFxZ25-xYM



In the USA..... Dam removal – Why?



<https://thehound2.files.wordpress.com/2015/05/glines-removal.jpg>



http://dels.nas.edu/dels/resources/static-assets/besr/images/NPS_Glines%20Canyon%20Dam%20Removal.jpg



June 2, 2016 - Conservationists can now point to the largest dam removal project in the U.S. as a success story.

The ecosystem of Washington's Elwha River has been thriving since the removal of its hydroelectric dam system.

Recent surveys show dramatic recovery, especially in the near shore at the river's mouth, where the flow of sediment has created favorable habitat for the salmon population.

A new generation of salmon species, some of which are endangered, are now present in the river.

<https://www.youtube.com/watch?v=VipVo8zPH0U>

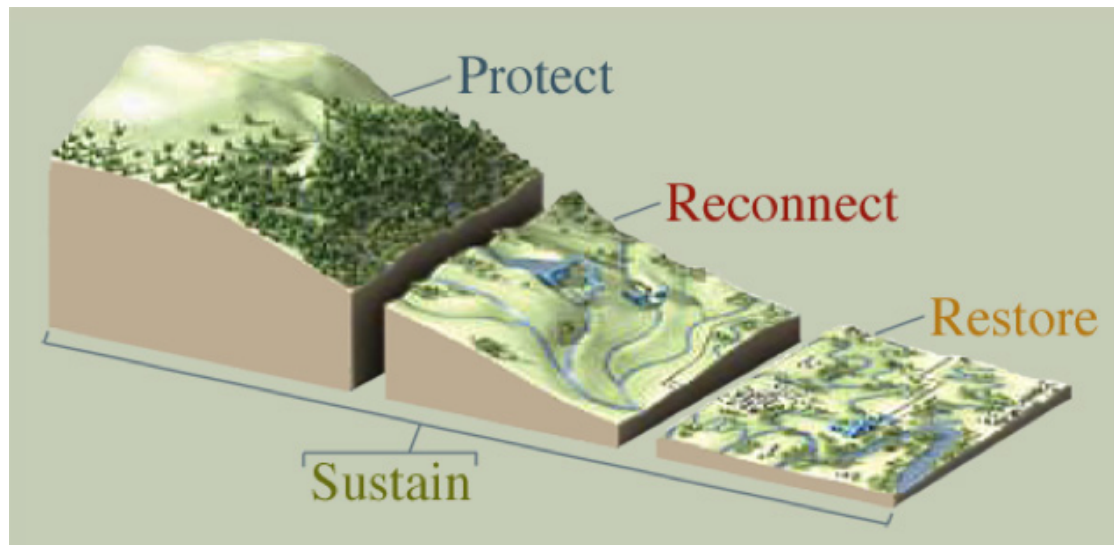
http://dels.nas.edu/dels/resources/static-assets/besr/images/NPS_Glines%20Canyon%20Dam%20Removal.jpg

[Learn more at American Rivers](#)

<https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/>

USA other river restoration efforts

Protect , Reconnect, Restore – efforts to restore rivers (from source to mouth) that support wild salmon and indigenous peoples



Reconnecting floodplains

*“Reconnecting Rivers to Floodplains;
Returning natural functions to restore
rivers and benefit communities”*

“Across the United States floodplains have been disconnected from rivers and modified on a massive scale resulting in a loss of floodplain benefits.

But floodplains and their benefits to people and nature can be restored by getting water on the floodplain at the right time, in the right amount, and for the right duration to support natural floodplain habitats”.

Riverine floodplains are dynamic systems that play an important role in the function and ecology of rivers. Where floodplains are connected to a river and periodically inundated, interactions of land, water, and biology support natural functions that benefit river ecosystems and people”

<https://www.americanrivers.org/conservation-resource/reconnecting-floodplains/>



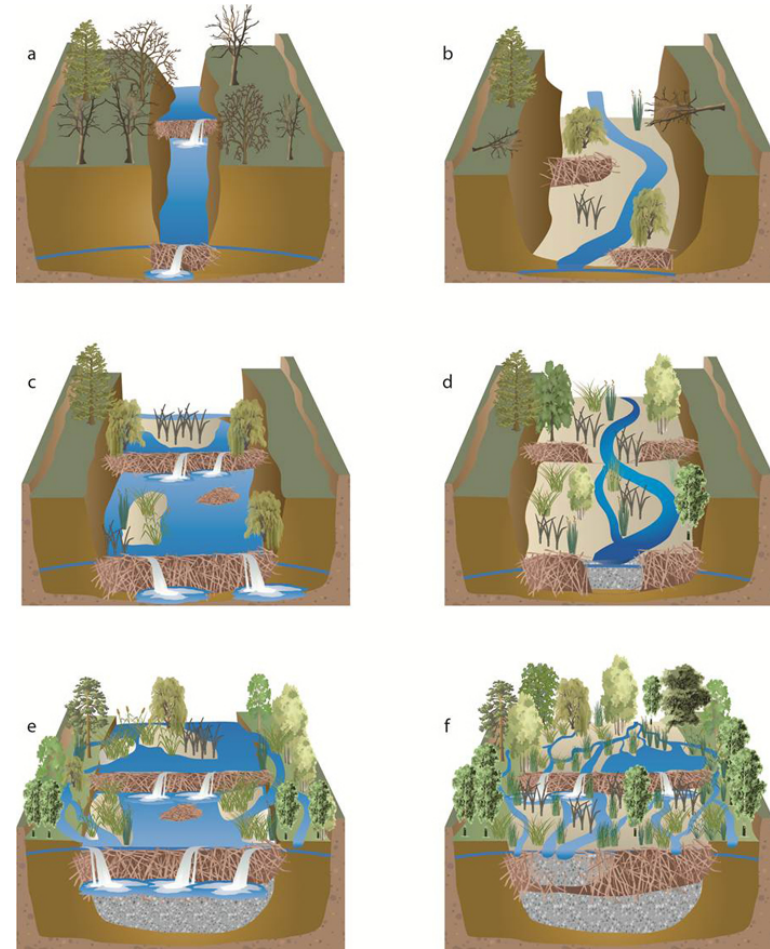
See: American Rivers
<https://www.americanrivers.org>

USA ... Working with beavers ... river restoration



<https://www.nwfsc.noaa.gov/research/divisions/fe/wpg/beaver-assist-stld.cfm>

<http://creation.com/beavers>



Science
Unwrapped

Leave it to Beavers

Lessons from Nature's River Restoration Engineers

JOE WHEATON

*USU Department of
Watershed Sciences*

USU Ecology Center

FRIDAY, SEPT. 11

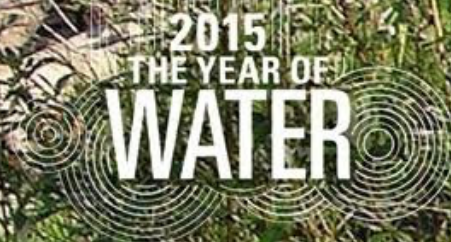
7 pm

**Eccles Science Learning
Center Auditorium (ESLC 130)**

Free Admission



College of Science
UtahStateUniversity



www.usu.edu/science/unwrapped

<http://beaver.joewheaton.org>

In China Wild river protection

Great News for China's Last Free-Flowing River



From www.internationalrivers.org - December 2, 2016 10:13 AM

New plans show that the Chinese government no longer plans to dam the Nu-jiang, China's last free-flowing river. This is a great success for the country's environmental movement.

“The Nu River - known as the Salween in Thailand and the Thanlwin River in Burma - is a treasure of biodiversity and China's last free-flowing river.

Through great educational efforts, China's budding environmental movement managed to stave off dam building plans on the river in 2004 and 2009. In 2013, the Chinese government announced new plans to build five hydropower plants on the undammed river.

Since then, NGOs like Green Watershed, Green Earth Volunteers and International Rivers have worked hard to document the unique ecological value of the Nu River and the serious environmental and geological risks of the proposed dam cascade.

The Power and Hydropower Development Plans for the 13th Five-Year plan period (2016-2020) no longer include any dams on the Nu River”

In Australia

- Environmental flows – MDB Plan
- Removal of willows along water courses (pests)
- Management or introduced aquatic species
- Riparian rehabilitation / fencing
- Reef Water quality Protection Plan – protecting GBR (Interconnections to riverine water)
- Fish ladders and fish hotels on inland rivers and re-snagging



<https://site.emrprojects summaries.org/category/fish/>

Rous Water
REGIONAL WATER SUPPLY

Richmond River High School - 5th September 2014

Wilson's River Catchment School Education and Restoration Project
500 trees for Wilson's River

Do you think it is important to learn about our Wilson's River Catchment? Yes = 93.5% & No = 6.4%

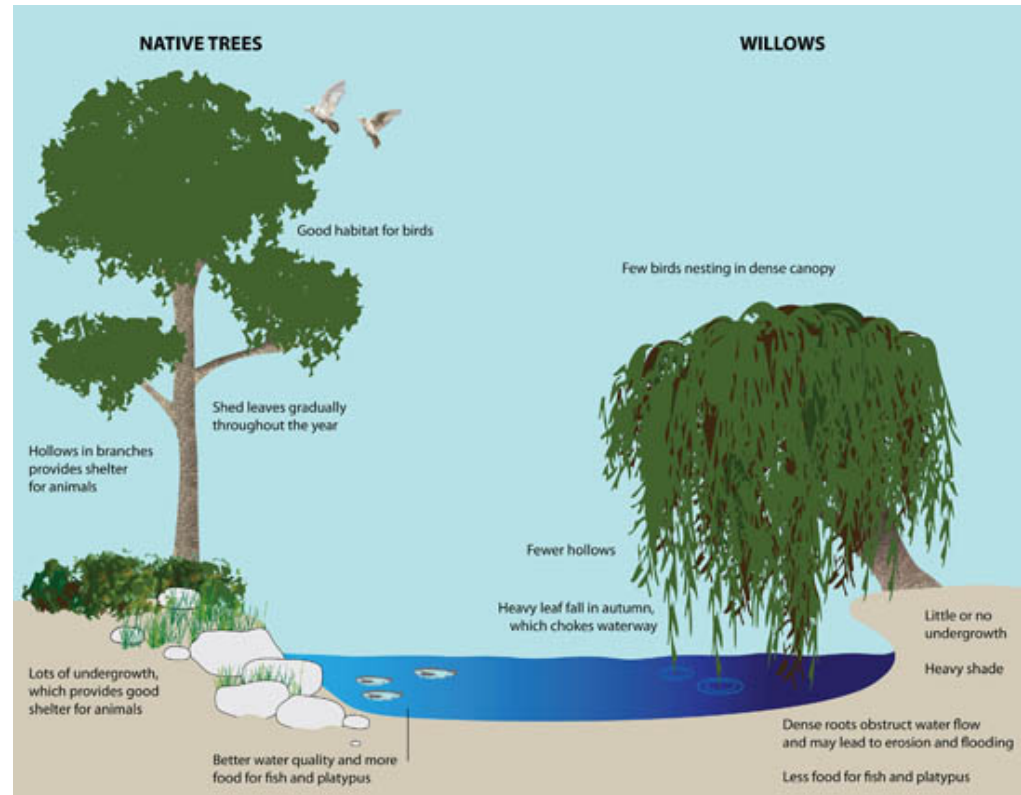
What was the most important thing you learnt?

- Water is good & current condition of the river
- Planting a tree & how tree planting is good for the environment
- How to Recycle and why it is important
- About our Koalas & the nature of corridors for habitat
- Everything about ecosystems
- Land conservation is important
- What you can do as an individual to help to manage the environment and your impact
- Everything you do has an impact

Funded by:
NSW | ENVIRONMENTAL TRUST

<http://www.lgnsw.org.au/events-training/local-government-environment-awards/previous-winners>

EXOTIC PLANTS and ANIMALS ... willows



There are other exotic plants and animals that threaten Australia's riverine environments

See Geography Bulletin Edition 3 2016

<http://www.angfaqlld.org.au/aqp/blog/2013/06/19/landline-war-of-the-willows/>

Carp...

Carp were first introduced to Australia in 1859, but numbers exploded in the 1960s after an adapted fish-farming strain was accidentally released into the wild.

It's estimated carp make up around 80-90% of the fish biomass within the Murray-Darling Basin, Australia's most important agriculture region.

The carp are prolific breeders that compete with native fish.

Their toothless jaws mean they need to feed at the bottom of rivers, which causes erosion and makes the water turbid, reducing water quality.

<http://www.abc.net.au/news/2016-01-13/murray-darling-carp-plague-release-fish-virus-farmers-scientists/7084586>
http://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2195_factsheet-Carp_Villian_or_Victim.pdf



Carp were first introduced into Australia in the 1870s to fill ornamental ponds.



In the 1960s, carp escaped into the River Murray following their illegal introduction.



During the 1970s, carp rapidly spread through Victoria, NSW, South Australia and Southern Queensland.



The Boolara strain is now the most widespread carp and has the biggest impact in Australia. Carp is the most common fish found in the Murray-Darling Basin.



The future of carp will depend on cooperation between researchers, the community and government.

Carp eradication ... electronic fishing, herpes virus

Help **WATERWATCH** uncover where carp love to hang out this spring

20 T-SHIRTS TO BE WON

Carp are a major problem in Canberra and the upper Murrumbidgee waterways

CARP ♡ 20°C

Log your carp sightings at www.feralfishscan.org.au to enter the prize draw

Carp are easier to spot when getting ready to breed. This happens during Spring when the water temperature warms to around 20°C.

Recording these locations will help Waterwatch identify where carp love to breed and provide opportunities for controlling them.

For more information about carp and the 'Carp Love 20°C' competition go to www.act.waterwatch.org.au

WATERWATCH Upper Murrumbidgee

SUPPORTED BY ACT icon



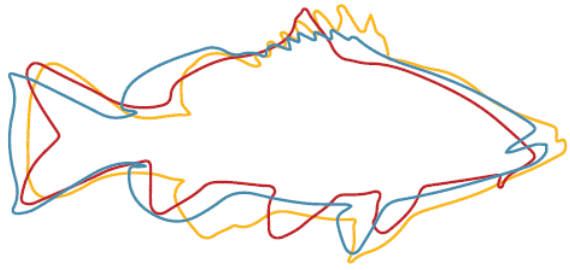
<http://www.bbc.com/news/world-australia-36189409>



https://www.google.com.au/search?q=willows+BAD+for+rivers&source=lnms&tbm=isch&sa=X&ved=0ahUKEwil16XkyNDSAhUMybwKHf4PC0EQ_AUIBigB&biw=1297&bih=1250#tbm=isch&q=impact+of+carp+on+AUstralian+rivers+&*&imgrc=TCg46mL67fT6zM

See my article on introduced aquatic species in the Geography Bulletin August 2016

https://www.google.com.au/search?q=willows+BAD+for+rivers&source=lnms&tbm=isch&sa=X&ved=0ahUKEwil16XkyNDSAhUMybwKHf4PC0EQ_AUIBigB&biw=1297&bih=1250#tbm=isch&q=impact+of+carp+on+AUstralian+rivers+&*&imgrc=8FJxDz1UqQMV6M



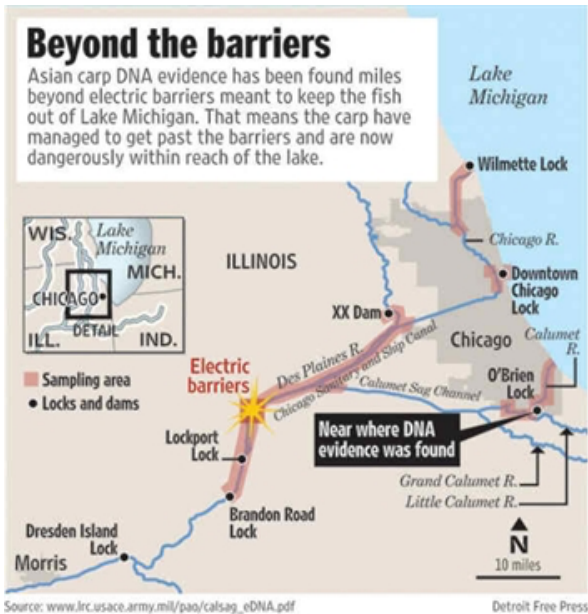
NATIONAL CARP CONTROL PLAN
RESTORING NATIVE BIODIVERSITY

http://www.frdc.com.au/knowledge/news_and_media/media_releases/Pages/carp.aspx



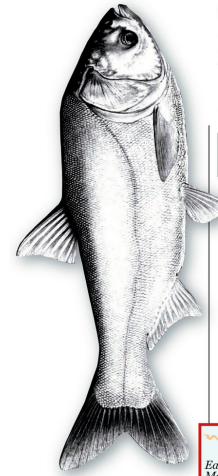
<http://lincolncountynevada.com/wp-content/uploads/2016/03/carp-rodeo-300x234.jpg>

USA : Potential comparative study

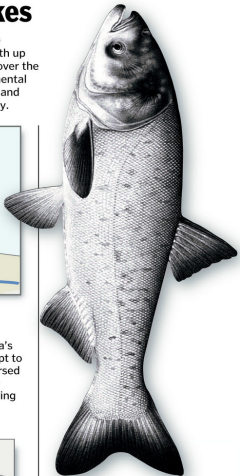


Carp crisis in the Great Lakes

The Asian Carp crisis — essentially the collective fear that the voracious bottom feeders that have been eating their way north up the Mississippi River for decades will break through and take over the Great Lakes — has become the most debated public environmental issue in the region. A number of studies by federal authorities and some of the states which could be most affected are underway.



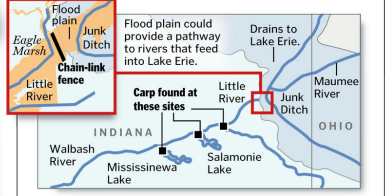
Silver carp
Hypophthalmichthys molitrix
The 50-pound flying fish is the YouTube sensation — leaping high out of the water when disturbed by a passing boat or water-skier. Boaters and jet-skiers have been seriously injured by the airborne fish. It was found in a half dozen different Arkansas rivers, streams or lakes by 1981. Because of its feeding habits, it is a direct competitor to fish native to the Great Lakes such as perch and walleye.



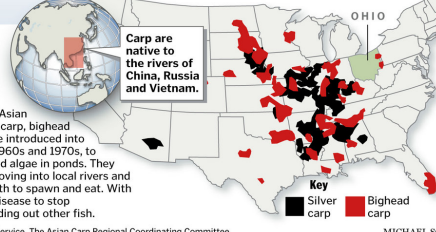
Bighead carp
Hypophthalmichthys nobilis
With no stomach, this fish eats constantly — vacuuming plankton, algae and everything else in its way — and can grow to more than 4 feet and 100 pounds. The older and bigger it gets, the more it reproduces. It began to appear in the Ohio and Mississippi rivers in the early 1980s. Because of its feeding habits, it is a direct competitor to fish native to the Great Lakes such as perch and walleye.



Worries about the front door: Lake Michigan
Officials are concerned about the fish finding a way past an electric barrier designed to keep them out of the Chicago area's waterways. More than 100 years ago, Chicago — in an attempt to keep its wastewater from polluting its drinking water — reversed the flow of its river away from Lake Michigan and toward the Mississippi River. That connected the two water systems, giving carp a pathway into the Great Lakes.



The back door might also be open: Lake Erie
Carp could find their way across this marsh during heavy flooding. That would put them into warm and shallow western Lake Erie, thought to be the friendliest environment for the fish — and also home to the most productive waters of the Great Lakes \$7 billion fishing industry. Officials constructed a chain-link fence to keep adult fish from crossing into the Maumee River system, but federal authorities are considering a permanent structure.



Journey north began in southern fish farming
Four different species of Asian carp — grass carp, black carp, bighead carp and silver carp, were introduced into American waters in the 1950s and 1970s, to control aquatic weeds and algae in ponds. They soon began to escape, moving into local rivers and streams and heading north to spawn and eat. With no natural predators or disease to stop them, they thrived, crowding out other fish.

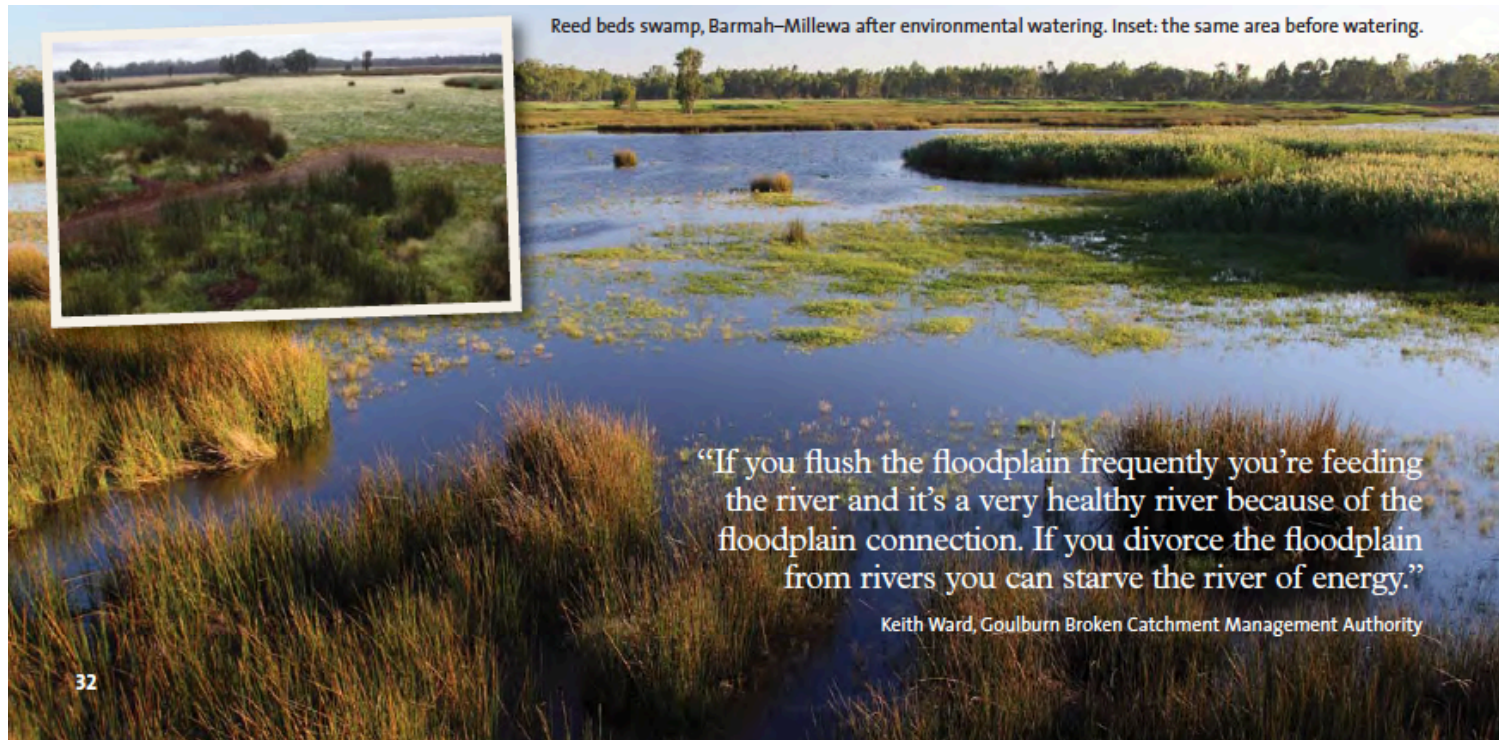
Speak out on carp issue today
The U.S. Army Corps of Engineers is holding a public comment session on its proposed study of the Asian carp issue. The open session is from 2-8 p.m. today at the Great Lakes Science Center, 601 Riverside Ave. in Cleveland. Go to glmris.acl.gov/ to learn more, submit an online comment or to register to speak at the event in Cleveland, in Cincinnati on Feb. 1 or other cities.

SOURCES: U.S. Fish & Wildlife Service, The Asian Carp Regional Coordinating Committee MICHAEL SCOTT, JAMES OWENS | THE PLAIN DEALER

http://blog.cleveland.com/metro/2011/01/asian_carp_crisis_lands_of_sho.html

In the USA Asian Carp are a similar threats – carp rodeos are held regularly along the Mississippi River

Environmental flows



Fish movement & habitat (biodiversity)

Down in the Coorong – helping fish find their way... | Finterest – Native Fish Strategy



From www.finterest.com.au - January 23, 3:59 AM

“ Lorraine Chaffer's insight: Management of riverine environments to protect and enhance biodiversity and maintain environmental linkages

Fish Moving Freely at Katfish Reach | Finterest – Native Fish Strategy



From www.finterest.com.au - December 16, 2016 3:47 AM

Taking Down Dams and Letting the Fish Flow



From www.nytimes.com - December 8, 2016 8:44 AM

On the Penobscot in Maine and other rivers in the U.S., several endangered species are rebounding with the reopening of spawning areas.

Recent articles from Lorraine's Scoop.it page for Environmental Change & Management

<http://www.scoop.it/t/year-10-environmental-change-and-management>

Why are attitudes to riverine environments changing are our values changing?

Understanding how riverine environments function holds the answer to this question

LETS GO TO THE SYLLABUS



Shamans perform a soul-cleansing ritual at Peguche Falls in Ecuador. The water is believed to give a person power to work and courage to dance for the fiesta.

From Geoworld 10 NSW

CONSIDER WORLDVIEWS / values

SYLLABUS

CONTENT FOCUS

Students develop an understanding of the **functioning of environments** and the scale of **human-induced environmental change** challenging sustainability.

They **explore worldviews** influencing approaches to environmental use and management.

Students undertake **an investigative study** of the causes and consequences of environmental change in an environment in Australia and another country.

They **compare and evaluate the management responses** in both countries and propose ways individuals can contribute to environmental sustainability

SYLLABUS

KEY INQUIRY QUESTIONS

- How do **environments function**?
- How do **people's worldviews** affect their attitudes to and use of environments?
- What are the **causes and consequences of change** in environments and how can this change be managed?
- Why is an **understanding of environmental processes and interconnections** essential for **sustainable management** of environments?

Introduction to Environmental Change

Environments

Students investigate the role and importance of natural environments, for example

- identification of the **function of natural environments in supporting life** eg maintaining biodiversity

Environmental change

Students investigate **human-induced environmental changes across a range of scales**, for example:

- brief examination of types, and extent, of environmental change

Environmental management

Students investigate **environmental management, including different worldviews and the management approaches of Aboriginal and Torres Strait Islander Peoples**, for example:

- discussion of varying environmental management approaches and perspectives

Investigative study

Riverine Environments

Select **ONE type of environment in Australia / a comparative study with at least ONE other country.**

Students investigate the **biophysical processes** essential to the **functioning of the selected environment**

Students investigate **the causes, extent and consequences of the environmental change (in each country)**

Students investigate the **management of the environmental change**

We have already seen the enormous potential for comparative studies with other countries

Riverine environment :What are my option?

Rivers at different stages (mountains to sea) LONGITUDINAL

- issues include climate change, glacial melt, pollution, damming

River channel and riparian zone (Traverse)

- issues include land clearing, agricultural pollution, habitat losses

River and its floodplain (Traverse) OR Wetlands connected to a river / river floodplain

- issues include disconnection between river & floodplain, flooding , wetland losses

River and its catchment (Traverse & longitudinal)

- cover a range of issues

Estuaries – where rivers meet the sea

..... there are many more possible environments at a local scale

NOT JUST LANDFORMS!

Use the NZ case study- find Australian comparative studies

MUST LINK TO HUMAN INDUCED CHANGE

LINK TO CHANGES TO RIVERINE HABITATS, RIVER / WETLAND / FLOODPLAIN FUNCTIONING

- Dam building
- Flood controls
- Climate change
- Pollution
- Urbanisation & industrialization
- Agriculture
- Climate change

 Scooped by [Lorraine Chaffer](#)

Special report: The blame game over NZ river health 



From www.newshub.co.nz - March 3, 7:08 AM

"In part four of our investigation into NZ rivers we look at who is really responsible for their decline."

BIOPHYSICAL PROCESSES

APPROACH 1 LONGITUDINAL STUDY

SOURCE TO MOUTH (mountains to sea)

Where does river flow come from? SOURCE

Downstream changes

Downstream changes in habitat

Why is river flow important – river ecosystems and floodplain linkages



<http://www.panoramio.com/photo/87882501>

MOUNTAINS TO SEA

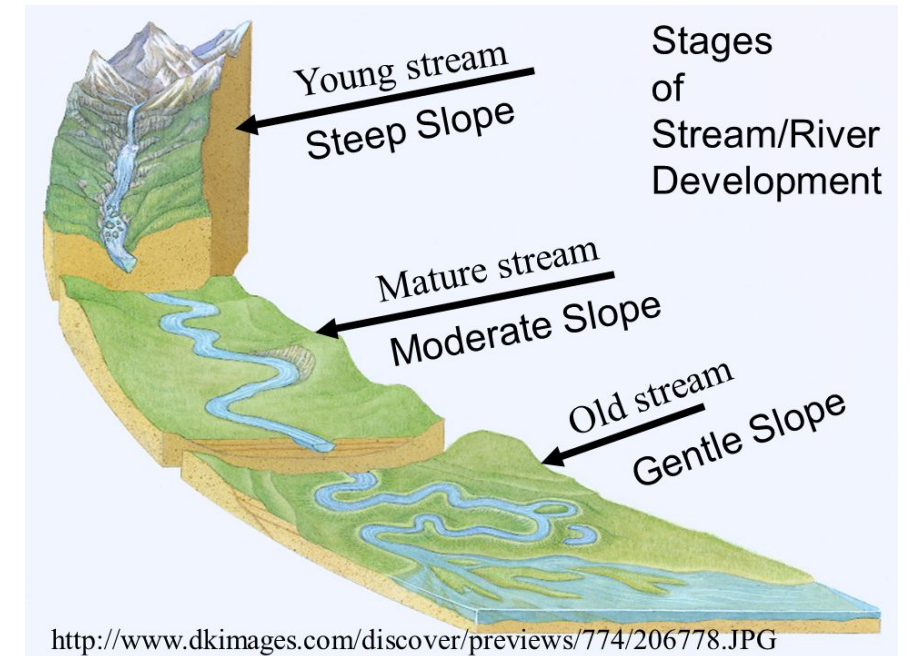
“The ages of a river

We can divide each river up into three ages, comparable to the life phases of human beings: youth, maturity and old age.

These three phases roughly correspond to the regions the river runs through.

The river’s course is its life, its entire journey from source to mouth where it sheds its banks and merges with the water of the sea”

http://www.unesco.org/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DOW01_1.0.pdf



Source to mouth

“Rivers, blood of the earth

Along its entire route, a river is a fundamental resource not only for human life but for fauna and Flora too. Each and every river is crucial to the equilibrium of the environment and biodiversity. That is why rivers must be considered a most precious good, to be guarded and protected from all forms of pollution or excessive exploitation.

In some cultures, like the U’wa Indians of Colombia, quite unlike western culture, the river itself is seen as a “living organism”: it is the blood that nourishes the earth.”

(WORLDVIEWS)

http://www.unesco.org/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DO_W01_1.0.pdf



Okavango Delta

“The abundance of life is mind boggling: more than 530 bird species, thousands of plant species, 160 different mammals, 155 reptiles, scores of frogs, countless insects”

<http://news.nationalgeographic.com/news/2014/06/140624-okavango-delta-unesco-heritage-site-botswana/>

Living environments ... change downstream

“Rivers are complex and dynamic environments adapted to natural variations in river flow (including droughts and floods) and availability of nutrients and sediment.

In the upper reaches rivers erode vertically creating deep valleys while downstream, where gradients are lower, they erode horizontally to create wide floodplains on which sediment is deposited.

Erosion and deposition create **different river habitats** and provide sediment and nutrients for freshwater species”.

http://www.unesco.org/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DOW01_1.0.pdf



Rivers as living environments

“The energy base of the food chain

Vegetation in the river leads organic material to become caught and trapped. The outcome of this process is that an extensive quantity of organic material (like branches and leaves) is, as it were, stored up, and this is the energy base for the food chain of all creatures living along rivers

The river as an **ecological highway**

Rivers might well be seen as “green highways” which **link up a succession of natural zones**. Even where human action and presence is marked, the river and its ecotones are still vital areas, used both by plants and animals for movement and reproduction.

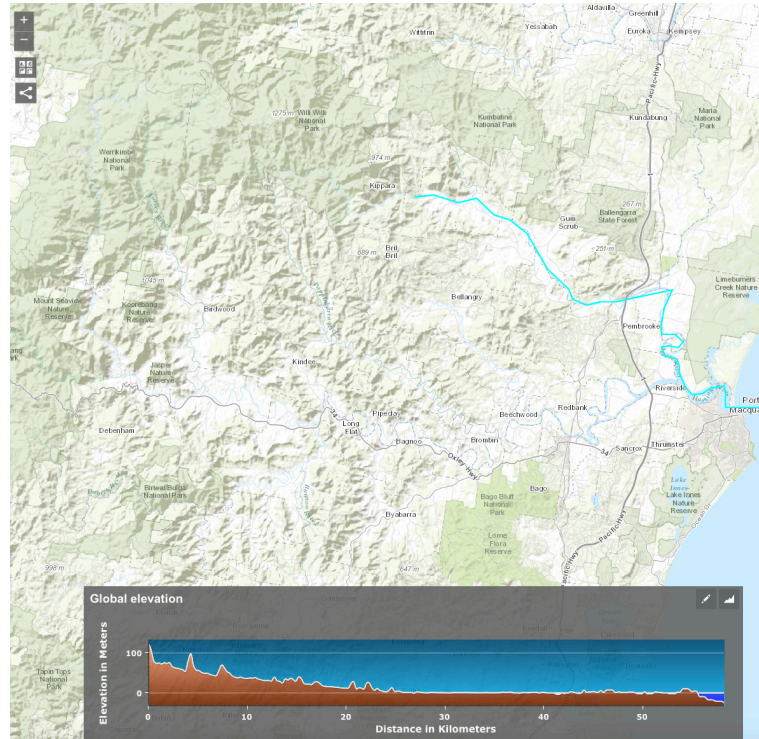
The migration of birds, for example, generally follows paths marked by rivers, and some trees, especially in the ecotones, use the flowing water to disperse their seeds. Rivers are thus extremely important interlinking passageways in a wider network, the ecological network itself.”

http://www.unesco.org/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DO_W01_1.0.pdf

DRAW a river profile - longitudinal or cross valley

Find a tributary, create a path downstream to see the general profile from start to finish.

Ignore rises as sometimes your line will cross over a ridge or spur – it is the overall profile you are looking at



ESRI Global elevation tool

Also use Google maps and Google Earth for profiles

Example from Port Macquarie NSW

Works equally well on local creeks and inland rivers.

[Global elevation](http://esriukeducation.maps.arcgis.com/apps/Profile/index.html?appid=f0a2a2a3e1964129b22c715e31282f6c)

<http://esriukeducation.maps.arcgis.com/apps/Profile/index.html?appid=f0a2a2a3e1964129b22c715e31282f6c>

Integrate spatial technologies

INTERCONNECTIONS – downstream connections to other environments

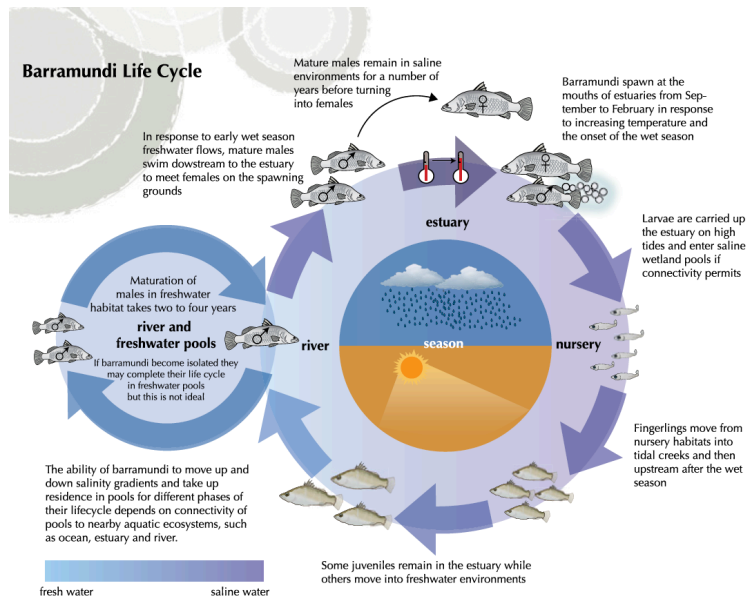
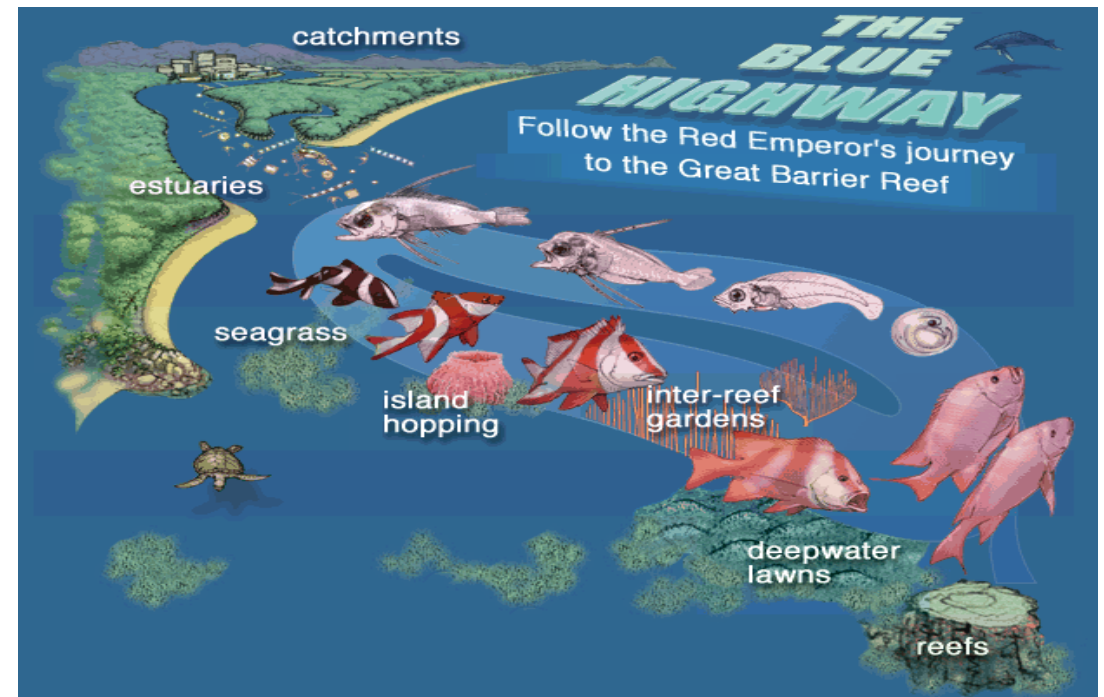


Figure 2.1 – A pictorial conceptual model of the barramundi lifecycle. Not all pictorial conceptual models are drawn on landscape bases (from the Fitzroy Coastal Floodplain Wetlands guide, DERM 2011).

<https://wetlandinfo.ehp.qld.gov.au/wetlands/resources/pictorial-conceptual-models.html>

LINKS BETWEEN RIVERINE & MARINE ENVIRONMENTS



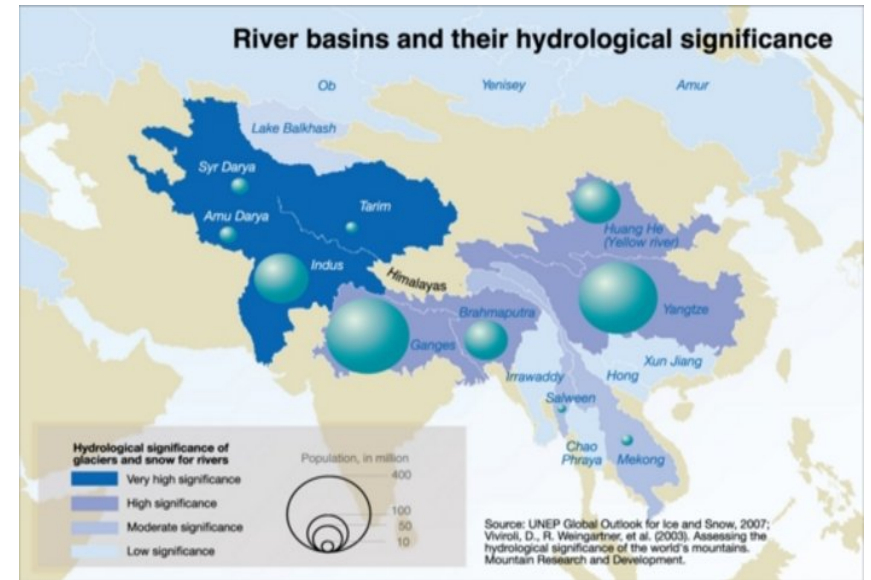
Use conceptual diagrams

Source

The third pole: Climate change implications for processes

Melting ice / glaciers

- Downstream flooding e.g. (Link to Room for the River)
- Future water flows reduced as ice disappears
- Environmental implications downstream



https://commons.wikimedia.org/wiki/File:Glacial_melt_water_carving_the_ice,_river_source_Himalayas_India.jpg

UNEP 2007 report on significance of ice (glaciers) & snow for riverine environments

What happens when we build a dam?

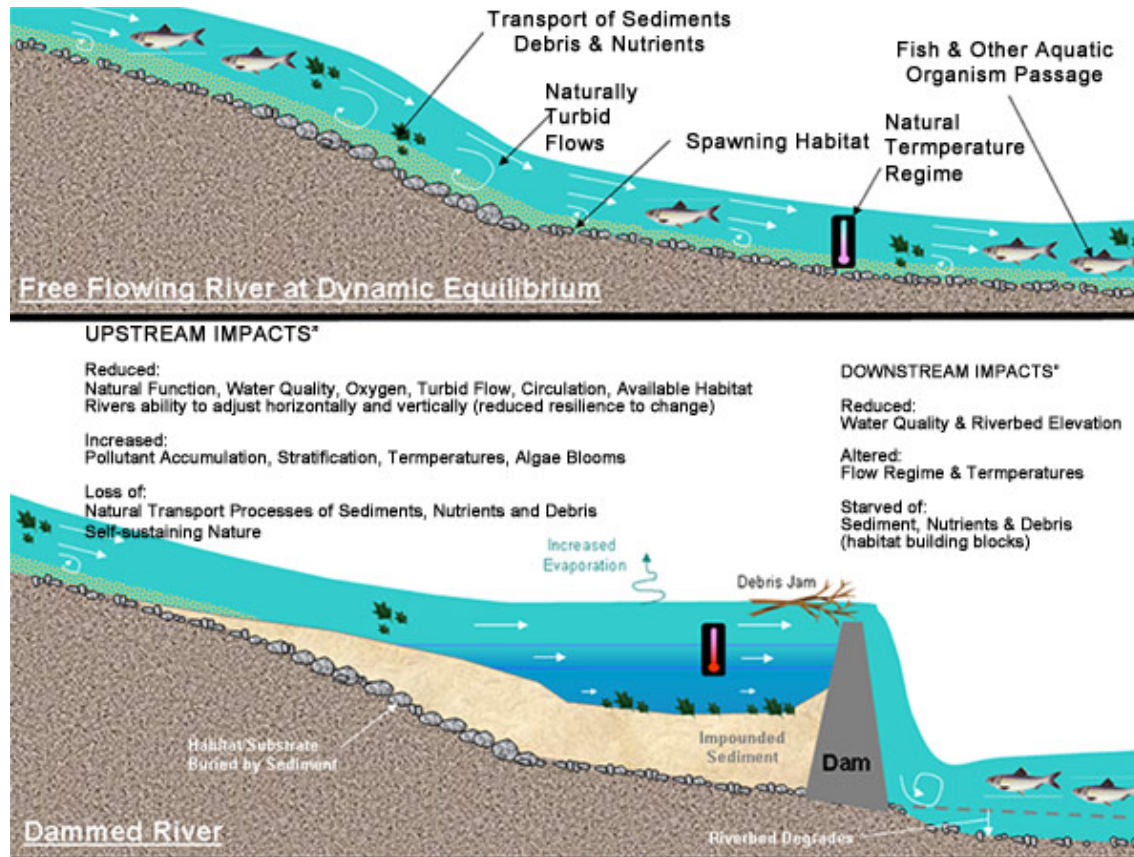


National Geographic:

Glen Canyon Dam USA

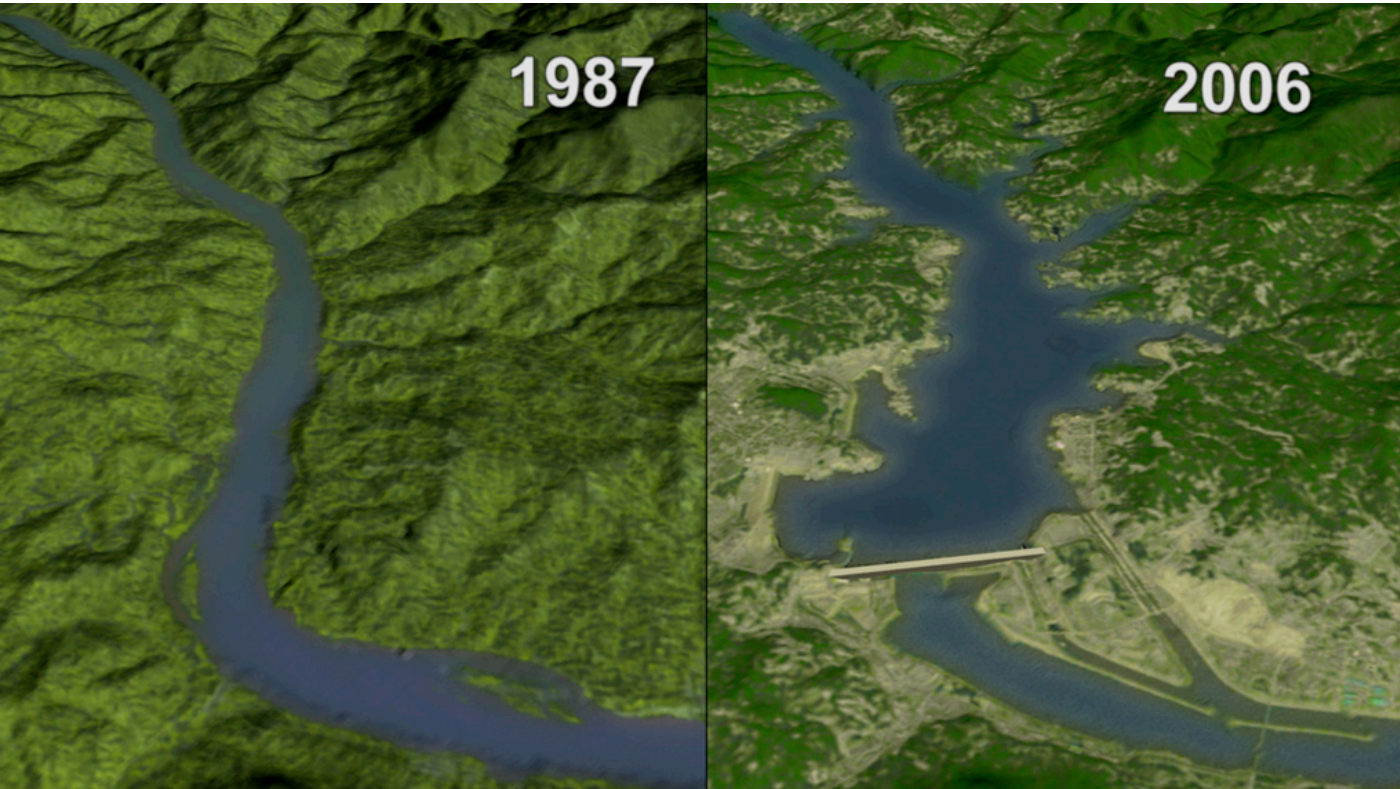
Comparative study in
Australia
(Snowy River)

Dams change rivers



- Reduction of downstream flow > contraction of inland lakes and seas e.g Aral Sea
- Reduction of nutrients at mouth of river > negative impact on commercial fisheries at coast
- Nutrients trapped behind dams > loss of mangrove forests in coastal areas
- Unnatural flow pattern of the river > riverbank erosion downstream > disruption to riverine species of birds and mammals
- Fewer floods downstream > increased urbanisation on floodplain
- Disruption to migratory patterns of river fish

There are lots of images showing change



3 GORGES DAM IN CHINA

<http://www1.american.edu/ted/ICE/china-dam-impact.html>

MEKONG DAMS: BENEFITS VS IMPACTS

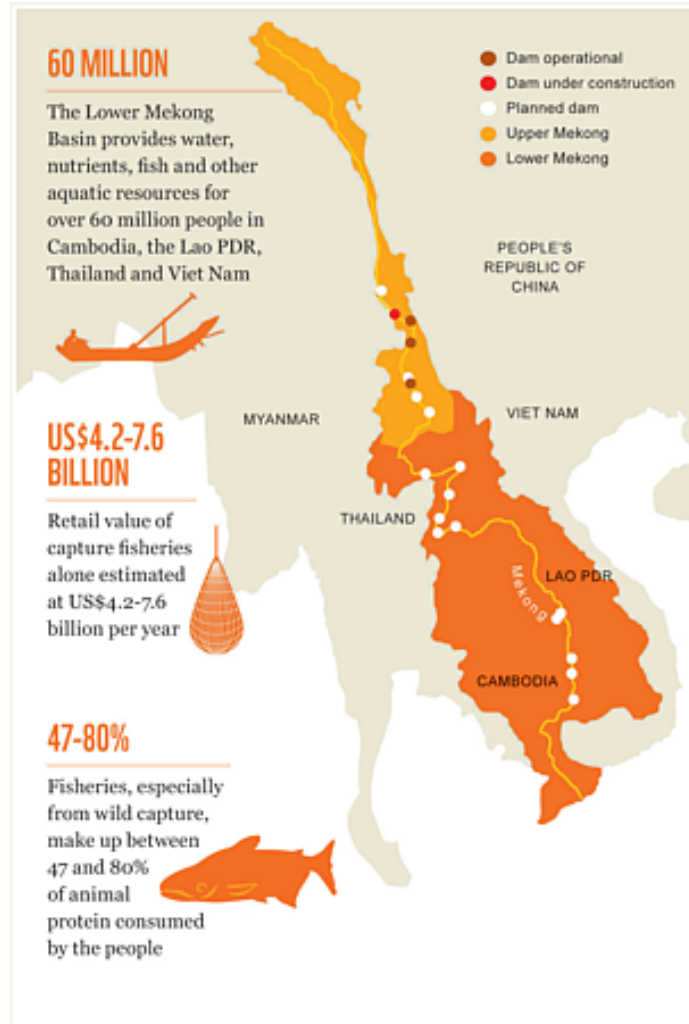


<http://s.ngm.com/2015/05/mekong-dams/img/china-xiaowan-dam-615.jpg>

<http://www.nature.com/news/2011/111019/images/map850.jpg>

Incorporate ASIA

Impact of dams on fisheries and biodiversity



<http://www.smh.com.au/content/dam/images/g/h/y/n/8/y/image.related.articleLeadwide.620x349.ghobvi.png/1436243078122.jpg>



<https://i.guim.co.uk/img/static/sys-images/Guardian/Pix/pictures/2015/5/6/1430916783608/423cc180-6b06-4d2b-b0e2-b3e5a130d4db-620x372.jpeg?w=700&q=55&auto=format&usm=12&fit=max&s=ce72d2f9627985f902c5f998acf0e72d>

http://d2ouvy59p0dg6k.cloudfront.net/img/mekong_dams_and_fisheries_478605.png

A tricky balancing act. BBC REPORT

<http://www.bbc.com/future/story/20120627-dammed-if-you-do>

“Of all the ways we have engineered Earth in the Anthropocene, the Age of Man, surely nothing rivals our audacious planetary-wide re-plumbing of the world's waterways. But is our control of Earth's arteries causing dangerous clots?”



http://ichef.bbci.co.uk/wwfeatures/wm/live/1280_720/images/live/p0/0v/dc/p00vdc2b.jpg

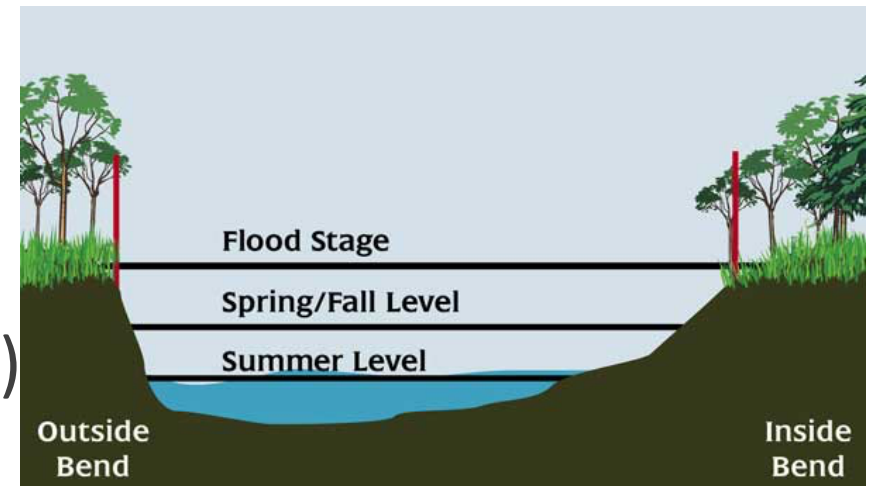
BIOPHYSICAL PROCESSES

APPROACH 2: TRAVERSE STUDIES

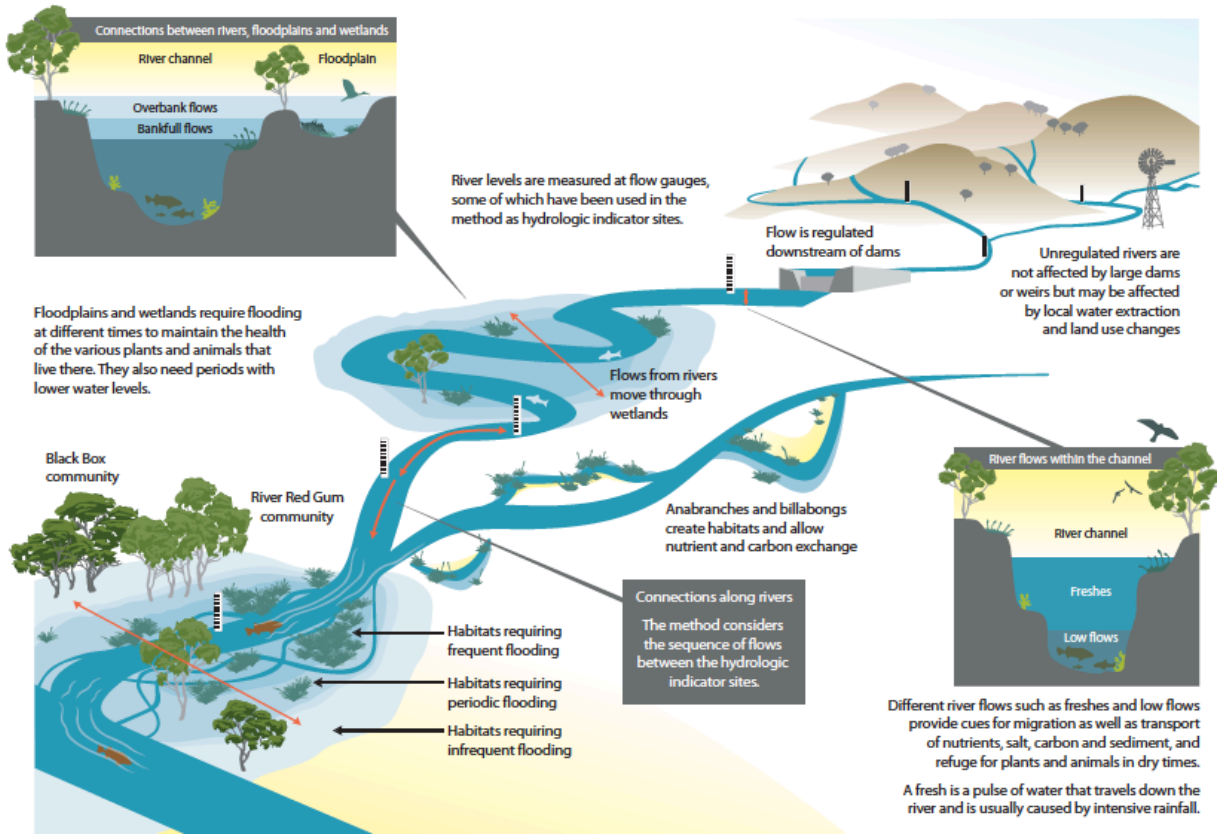
Bank to Bank (Channel & riparian zone)

River, wetland and floodplain Interconnections)

Whole catchment (Ridge to ridge)



River / wetland / floodplain connections



Excellent resources for MDBA

<http://www.mdba.gov.au/discover-basin/environment/river-wetlands-floodplains>

RIVER FLOWS

CONNECTING FLOODPLAINS AND WETLANDS



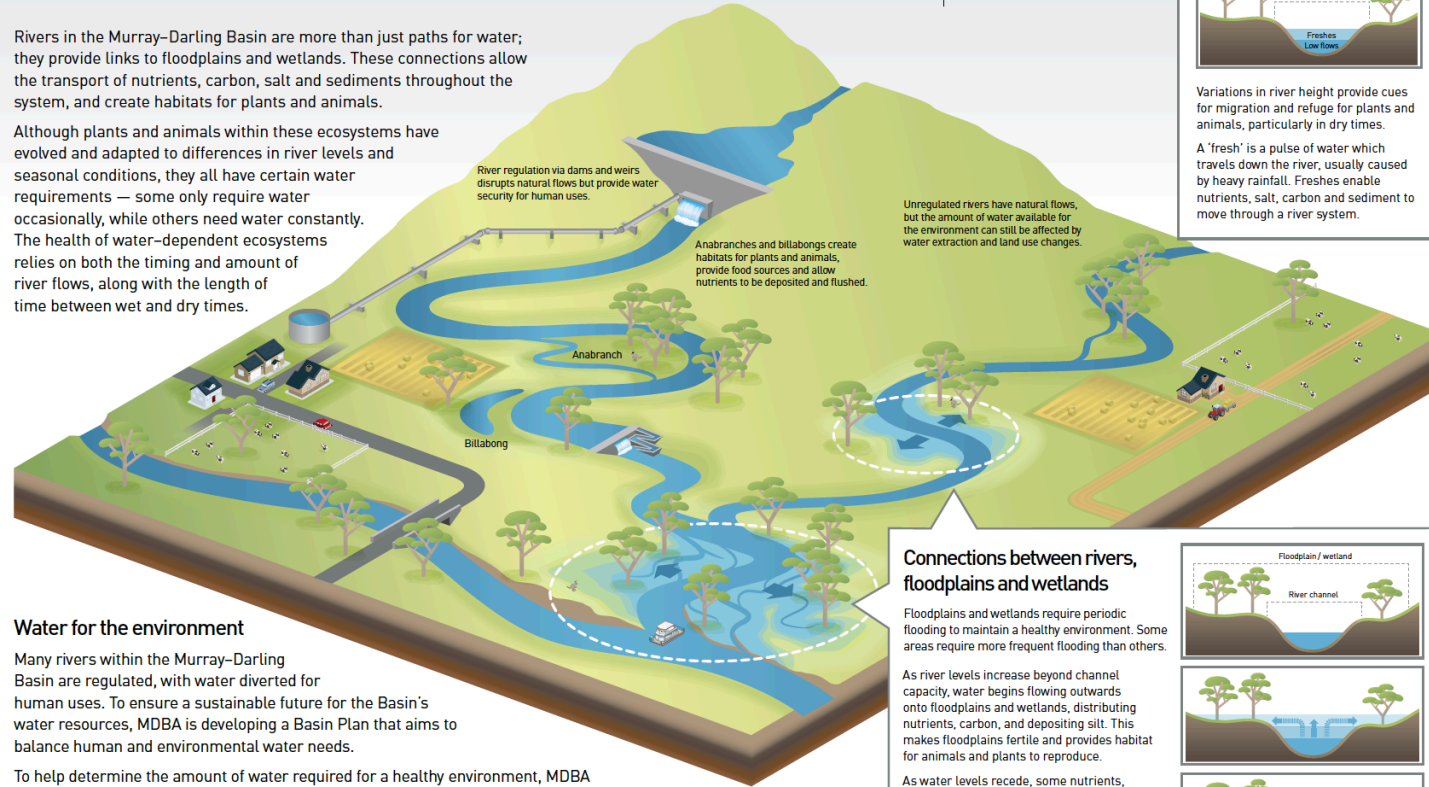
Rivers in the Murray–Darling Basin are more than just paths for water; they provide links to floodplains and wetlands. These connections allow the transport of nutrients, carbon, salt and sediments throughout the system, and create habitats for plants and animals.

Although plants and animals within these ecosystems have evolved and adapted to differences in river levels and seasonal conditions, they all have certain water requirements — some only require water occasionally, while others need water constantly. The health of water-dependent ecosystems relies on both the timing and amount of river flows, along with the length of time between wet and dry times.

Water for the environment

Many rivers within the Murray–Darling Basin are regulated, with water diverted for human uses. To ensure a sustainable future for the Basin's water resources, MDBA is developing a Basin Plan that aims to balance human and environmental water needs.

To help determine the amount of water required for a healthy environment, MDBA has chosen a number of locations within rivers, floodplains and wetlands across the Basin. These areas — known as 'hydrologic indicator sites' — have had their water needs assessed. This information is being combined with other data to determine how much water is required to support healthy ecosystems on a sustainable basis.



River regulation via dams and weirs disrupts natural flows but provide water security for human uses.

Anabranches and billabongs create habitats for plants and animals, provide food sources and allow nutrients to be deposited and flushed.

Unregulated rivers have natural flows, but the amount of water available for the environment can still be affected by water extraction and land use changes.

In-channel flow variation

Variations in river height provide cues for migration and refuge for plants and animals, particularly in dry times.

A 'fresh' is a pulse of water which travels down the river, usually caused by heavy rainfall. Freshes enable nutrients, salt, carbon and sediment to move through a river system.

Connections between rivers, floodplains and wetlands

Floodplains and wetlands require periodic flooding to maintain a healthy environment. Some areas require more frequent flooding than others.

As river levels increase beyond channel capacity, water begins flowing outwards onto floodplains and wetlands, distributing nutrients, carbon, and depositing silt. This makes floodplains fertile and provides habitat for animals and plants to reproduce.

As water levels recede, some nutrients, sediments, carbon and salt are pulled back into the river channel and carried downstream. Many organisms also return to the river.

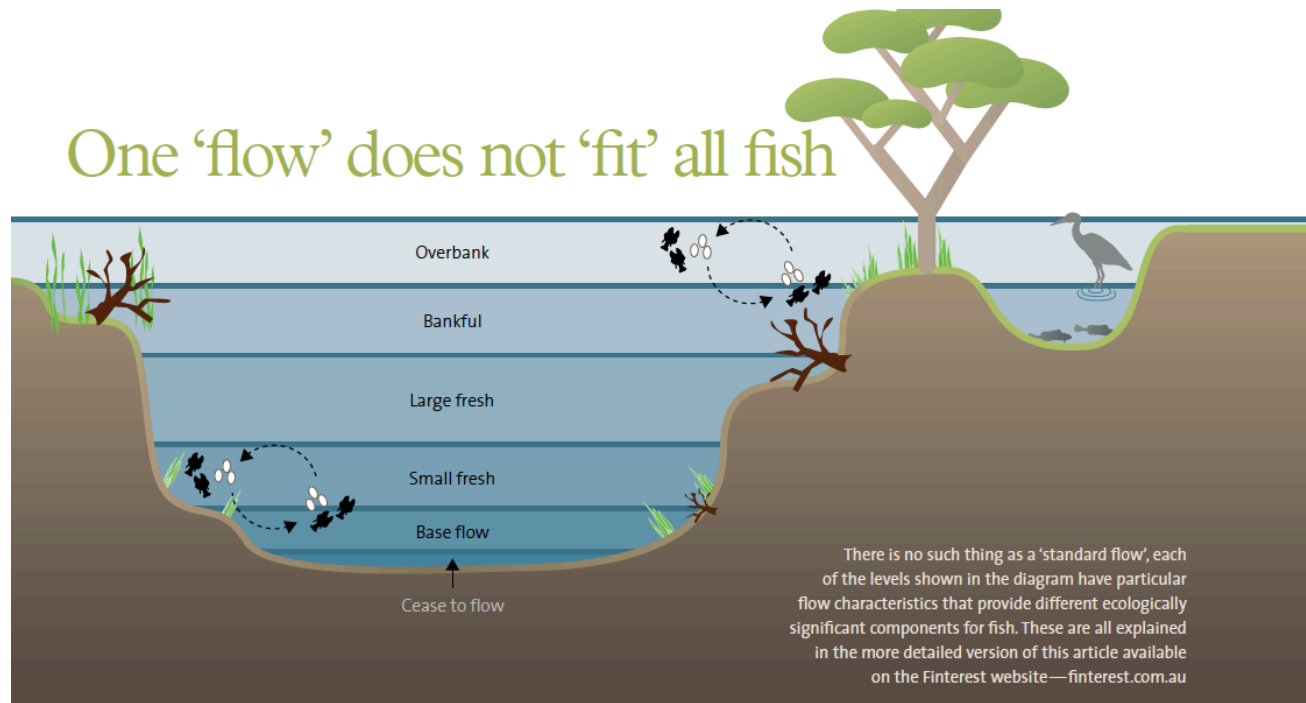
Legend:
■ Overbank flows
■ Bankfull flows
■ In-channel flows

MDBA publication 37/11

Excellent resources for MDBA
<http://www.mdba.gov.au/discover-basin/environment/rivers-wetlands-floodplains>

A rivers and riparian zones

One 'flow' does not 'fit' all fish



Features / functions of a natural stream

Dynamics of a Natural Stream Ecosystem
 Healthy stream ecosystems support diverse communities of aquatic organisms

Hydrology: Water connects the watershed to the stream. In an undisturbed ecosystem, precipitation reaches a stream gradually by flowing over the vegetated land surface into the stream and by infiltrating the soil and flowing underground (as groundwater) toward the stream. Natural seasonal patterns of streamflow serve as life cycle cues to aquatic organisms.

Water chemistry: Nutrients such as nitrogen, phosphorus and carbon are required for all stream life. Nutrients are incorporated into algae, which are then consumed by other organisms, introducing the nutrients into the stream's food web.

Riparian Zone

Submerged leaves

Aquatic plants

Pool

Sediment

mussel Mussels (clams) live in soft sediments of streams and rivers, where they filter fine particles from the water.

Algae have short life cycles of days to weeks and can respond relatively rapidly to changes in water chemistry. The most common algae found in natural streams of small to moderate size are diatoms, which attach to underwater surfaces such as rocks and aquatic plants. The diatom *Cymbella* can be found in riffles, either as solitary cells or at the ends of branched stalks on rocks and other surfaces. The diatom *Epithemia* is commonly found on the surfaces of submerged aquatic plants. Algae are the foundation of most aquatic food webs.

stonefly

mayfly

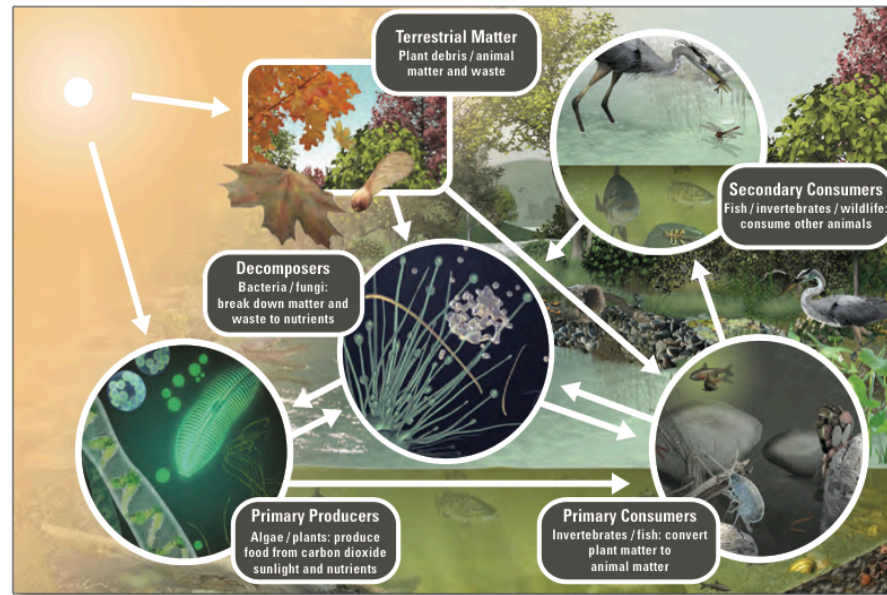
Macroinvertebrates, including these aquatic insects, have complex life cycles that occur over time spans of weeks to months. Most aquatic insects spend nearly all their life in the water as eggs and larvae and then leave the water and develop wings as adults. Many mayflies crawl on the surfaces of rocks in riffle areas, and feed by gathering fine

Illustration by Frank Ippolito

<https://water.usgs.gov/nawqa/ecology/pubs/cir-1391/images/NaturalStream.pdf>

<https://water.usgs.gov/nawqa/ecology/pubs/cir-1391/images/NaturalStream.pdf>

SIMPLE RIVER FOOD WEB



Environmental functioning

Figure 2-3. A simplified foodweb in a stream ecosystem, showing the interaction between energy coming from the sun and the biota, which include primary producers (diatoms and green algae), primary consumers (caddisflies, amphipods, and minnows), secondary consumers (herons, bass, dragonflies, and stoneflies), and decomposers (bacteria and fungi). (Drawing by Frank Ippolito, Production Post Studios, 110 North Fulton St., Bloomfield, N.J.)

<https://water.usgs.gov/nawqa/ecology/pubs/cir-1391/images/NaturalStream.pdf>

RIVERINE HABITATS

Riverine habitats vary from deep pools to shallow, fast flowing rapids, protected riverbanks and riverbed sediments such as gravel and rocks.

Within each habitat aquatic plants, sediment and nutrients support complex *food webs*.

Debris such as tree branches is an essential source of food, habitat and surfaces for small aquatic plants to grow on (biofilm).

Aquatic species are adapted to stable water *temperatures* within rivers

The *lifecycle* of fish species such as salmon and barramundi involves *migration* between different river habitats.

RIPARIAN ZONE

The riparian zone plays an important role in healthy river functioning by stabilising riverbanks, slowing the runoff entering channels, trapping sediments, reducing water temperatures and providing food and habitats, such as snags, for aquatic species.

In healthy river catchments vegetation cover and wetlands slow runoff, remove pollutants and allow water to percolate slowly into aquifers, which recharge streams with clean water.

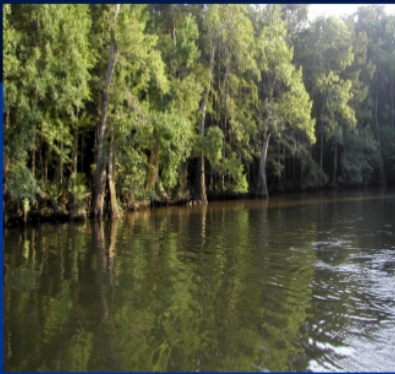


http://aubreyshepherd.blogspot.com.au/2012_06_01_archive.html

Importance of riparian zones

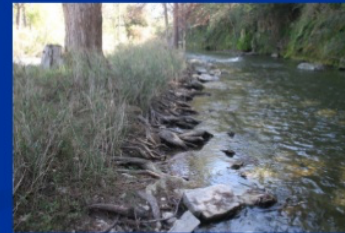
Characteristics of a Healthy Riparian Area:

- Diverse collection of native vegetation in close association with water.
- Many of these plants have deep roots that:
 - bind the soils of the streambank
 - protect against erosion



Benefits of Healthy Riparian Areas:

- Provide important habitat for wildlife and fish
 - Food, shelter, shading, travel corridors
- Improve water quality
 - Filter & catch sediment
 - Assimilate pollutants
- Streambank stability
 - Reduce velocity of flood water
 - Armor banks



Recognizing an Impaired Riparian Area:

- Lack of vegetation, exposed soil, and eroding banks
- Presence of vegetation more typical of upland sites
- Sites dominated by exotic or introduced species
- Park-like settings or ones that have been continuously grazed





Riparian Chain Reaction

Adequate Vegetation:

- Protects banks from excess erosion
- Dissipates energy and slows the velocity of floodwater
- Sediment dropped
- Sediment trapped and stabilized
- Floodplain / riparian sponge is enlarged
- Increased groundwater recharge
- Base-flow is sustained over time

<https://www.slideshare.net/BosqueRiver/riparian-stream-restoration-bosque-river-stephenville>

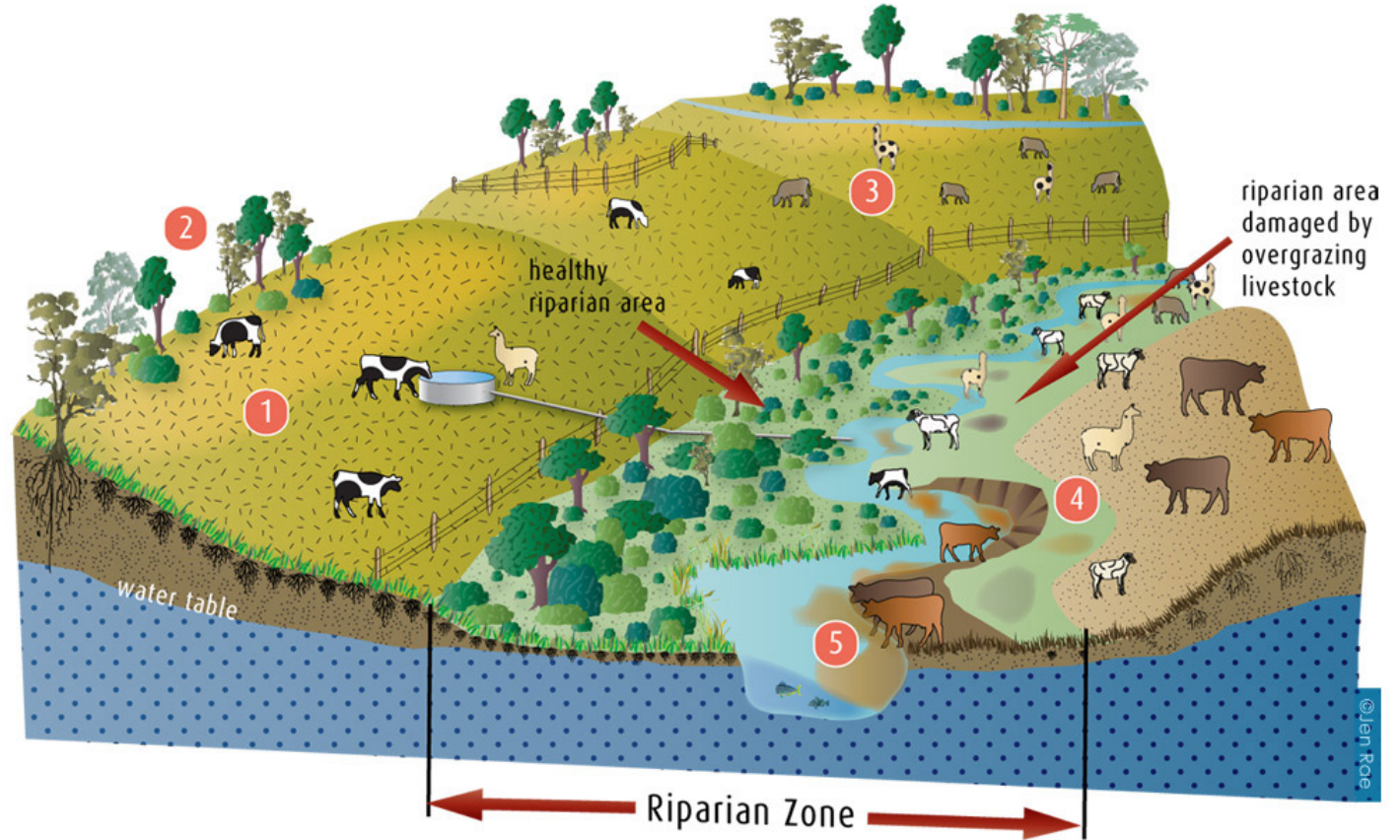


Another great Slideshare PPT: Understanding your remarkable riparian area

https://www.slideshare.net/mulebarn/riparian-area-management-sky-joneslewey-nueces-river-authority-resource-protection-and-education-director-president-hill-country-alliance?next_slideshow=1

Threats and management

<http://theriparianproject.com.au/about>



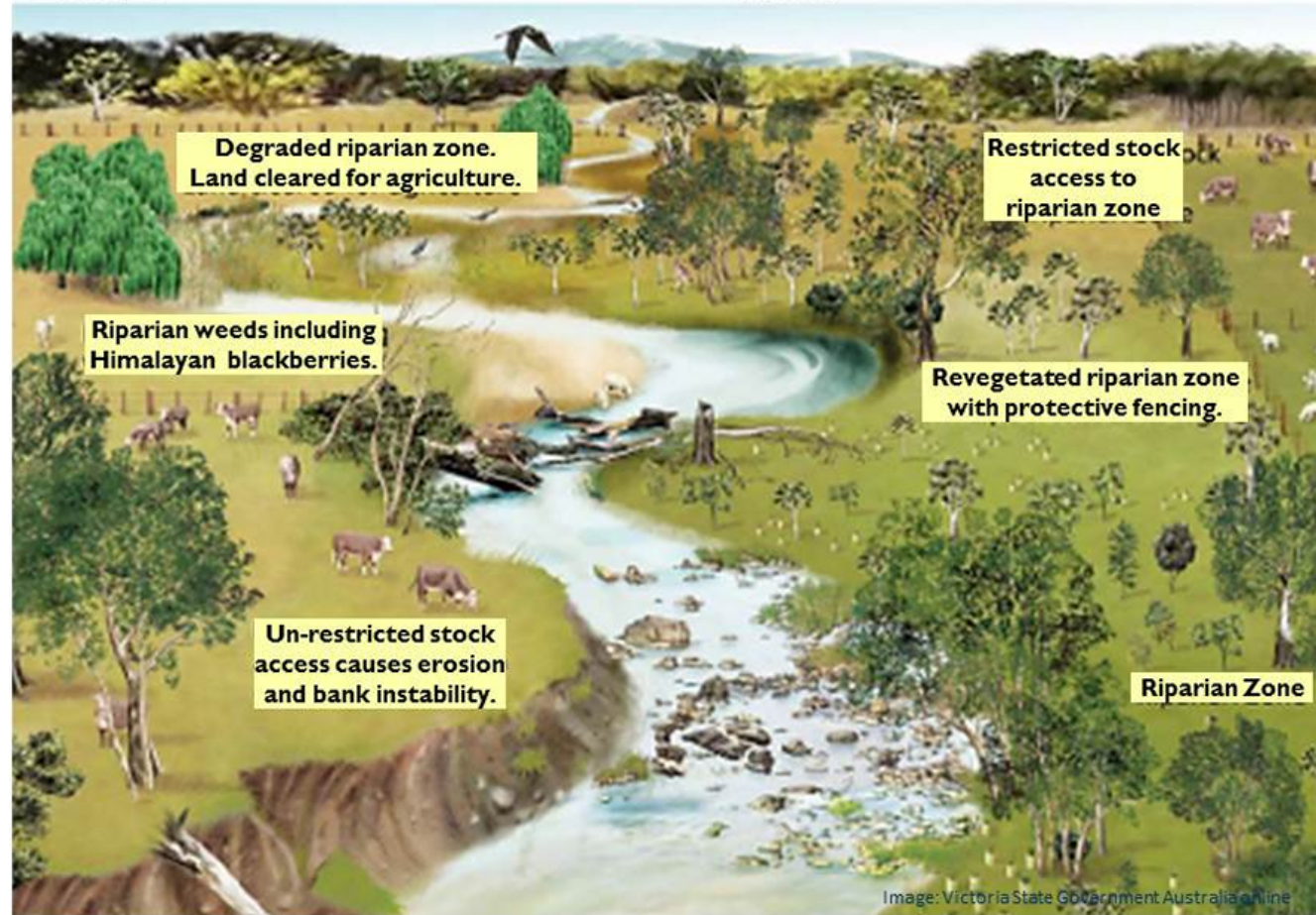
- 1 healthy uplands
- 2 indigenous shrubs & trees provide wildlife habitat and shelter for livestock
- 3 riparian areas protected from unrestricted livestock grazing managed with fencing
- 4 eroding river banks and loss of habitats and vegetation
- 5 river contamination

©Iain Ripe

Use conceptual diagrams

Before

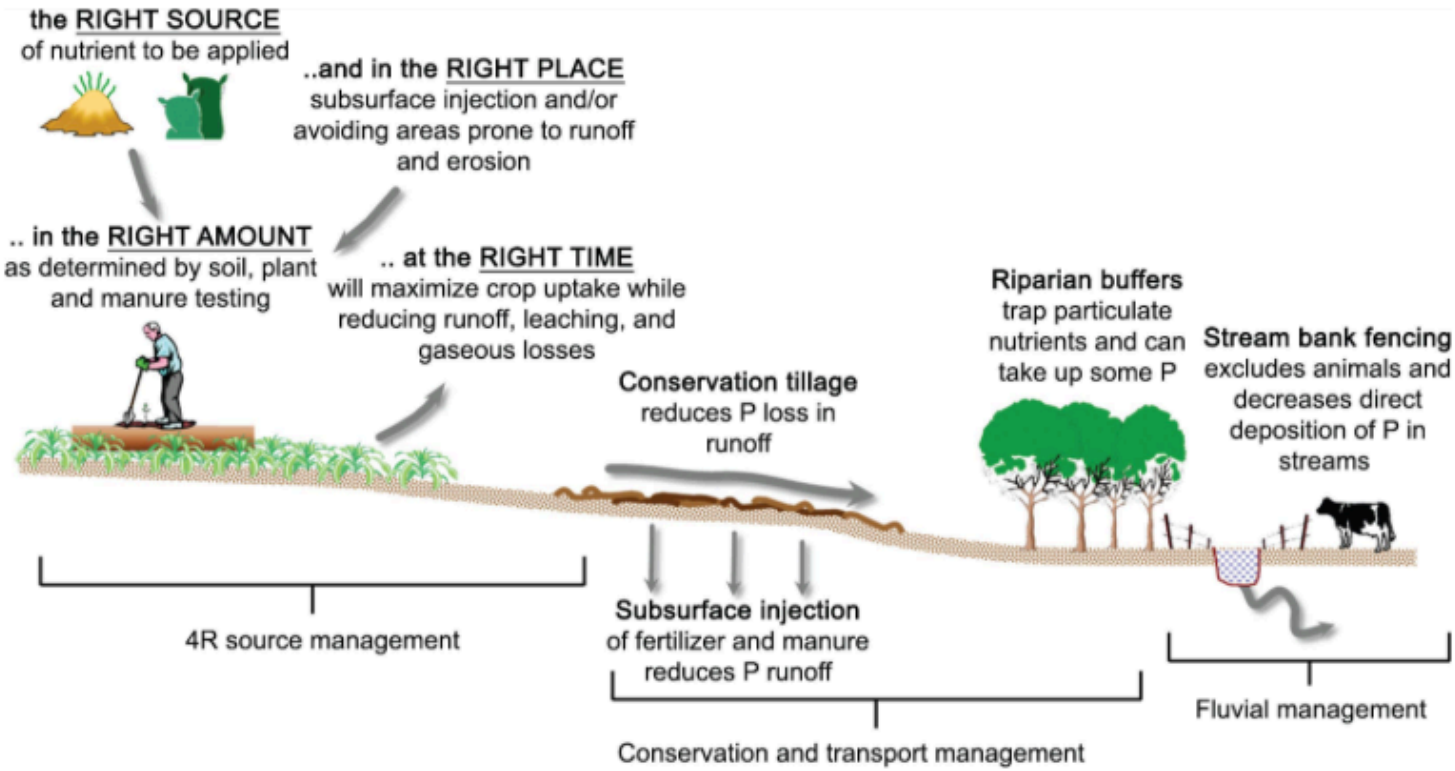
After



https://www.google.com.au/search?q=river+cross+section+diagram&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiPo5GphtbSAhVHO7wKHXRrBr0Q_AUIBigB&biw=1297&bih=1252#tbm=isch&q=river+and+riparian+zone&*&imgrc=ZGDmHnuSciiKxM

Impact of agriculture

See NZ example.



http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-90162016000100001

Link to sustainable biomes topic

DROUGHTS & FLOODS

When there is too much or too little water, rivers suffer the consequences.

Today we are frequently taken aback at how frequently droughts and floods occur in certain parts of the world.

A riverbed can carry only so much water and when there is too much it literally bursts its banks and floods the surrounding land.

http://www.unesco.org/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DOW01_1.0.pdf

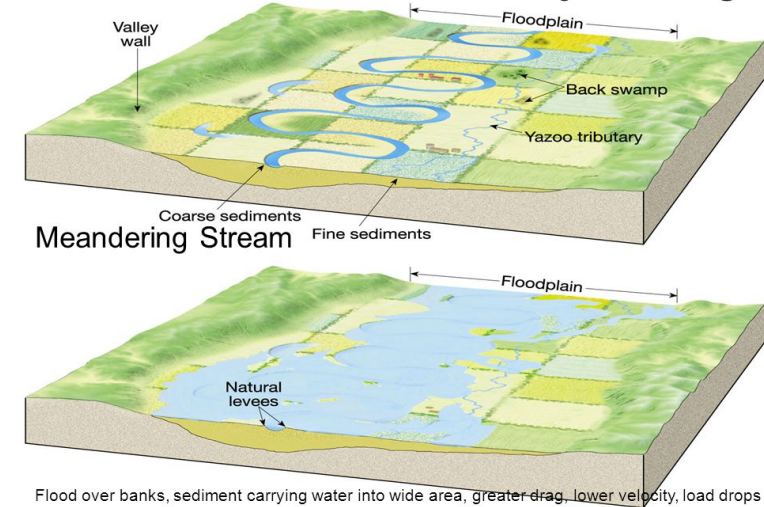
The importance of flooding

Floods transfer water, sediment, nutrients such as Nitrogen and organic matter (leaves, bark) between rivers and floodplain environments including wetlands, swamps and old river channels (billabongs). Each year Europe's rivers deposit an estimated 250 tonnes of sediment and 96 tonnes of fine organic matter per hectare onto floodplains.

Floods renew alluvial soils and nourish rivers, stimulating terrestrial and aquatic plant growth and wildlife breeding cycles.

Many native species use high flow and flood events to migrate between habitats. Golden Perch in the Murray River migrate as far as 1000 kilometres upstream to spawn and the Red Emperor fish on Great Barrier Reef begins its life cycle in Queensland's rivers.

Formation of natural levees by flooding



National Geographic slideshow on Floodplains

<http://www.nationalgeographic.org/encyclopedia/flood-plain/>

FLOOD MANAGEMENT HARD & SOFT OPTIONS

“Managing development of flood plains is a critical responsibility for regional and **urban planners**. The benefits of flood plains, including prime agricultural land and desirable housing locations, must be balanced with the personal and **economic** threats posed by floods.”

National Geographic

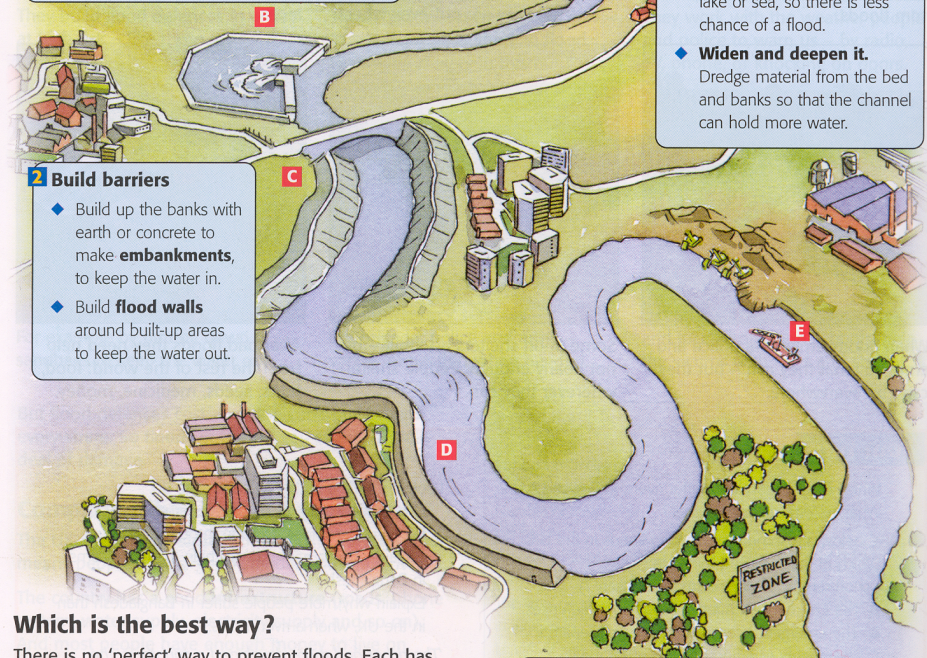
<http://www.nationalgeographic.org/encyclopedia/flood-plain/>

How can we control or prevent floods?

When rivers flood, we help the victims with shelter and food. But that's a short-term solution. We also try to prevent floods in the future. Here are four ways to do that:

1 Control the water level

- ◆ Build a **dam** to trap and store water, and release it in a controlled way. (A dam can also be used to give electricity.)
- ◆ Build **pumping stations**. When the water level rises, you can pump water out into temporary storage basins.



2 Build barriers

- ◆ Build up the banks with earth or concrete to make **embankments**, to keep the water in.
- ◆ Build **flood walls** around built-up areas to keep the water out.

3 Alter the river's channel

- ◆ **Straighten it**. This will speed up the flow of water to the lake or sea, so there is less chance of a flood.
- ◆ **Widen and deepen it**. Dredge material from the bed and banks so that the channel can hold more water.

Which is the best way?

There is no 'perfect' way to prevent floods. Each has problems – and may fail! To make the best choice, you must consider:

- ◆ how often the river floods heavily
- ◆ how much damage it can do
- ◆ how much each method would cost
- ◆ how much you can afford to spend!

4 Control land use around the river

- ◆ Stop people building on the flood plain.
- ◆ Plant more trees in the drainage basin.
- ◆ Pay farmers to allow their fields along the river to get flooded. (That means less flooding somewhere else.)

NEW APPROACHES

Flood Management Strategies

Flood management aims to reduce the frequency and magnitude of flooding in order to limit the damage. Protection can be achieved by **HARD** or **SOFT-ENGINEERING** methods



HARD ENGINEERING INCLUDES:

- Levees, artificially raised and strengthened embankments
- Dams and weirs
- Diversion channels
- Retention basins and balancing lakes
- Artificially raised floodplains



Costs: expensive to build and to maintain; likely to cause environmental damage; may displace people
Benefits: generally effective - water supply, economic growth and stability assured in the short and medium term

SOFT APPROACHES TO THE MANAGEMENT OF FLOODING INCLUDE:

- Afforestation
- Floodplain zoning
- River restoration schemes
- Contour ploughing and strip farming along valley sides
- Improving flood forecasting



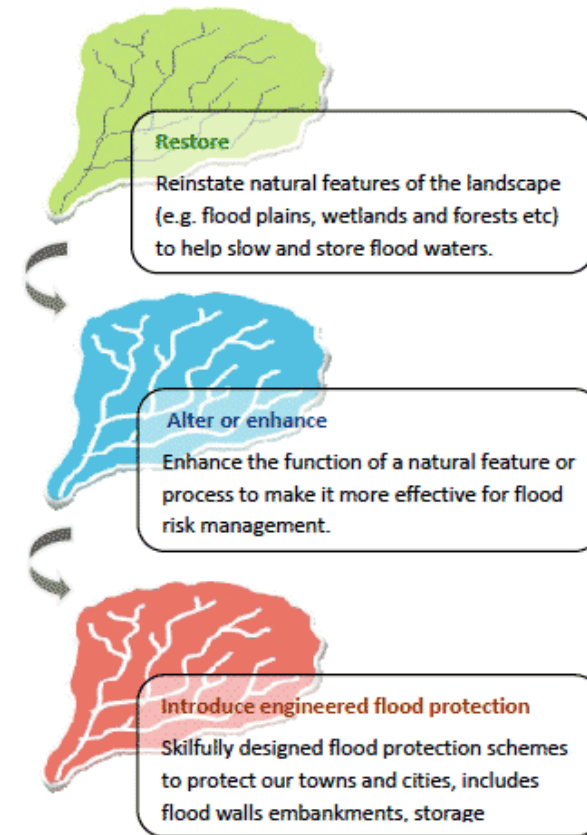
Costs: less effective than hard engineering, particularly in the short term
Benefits: less costly than hard engineering, environmentally sustainable in the long term



<http://www.anforme.co.uk/images/products/zoom/1284652220-90429000.jpg>

Where does ROOM FOR THE RIVER FIT?

What options are used in Australia?



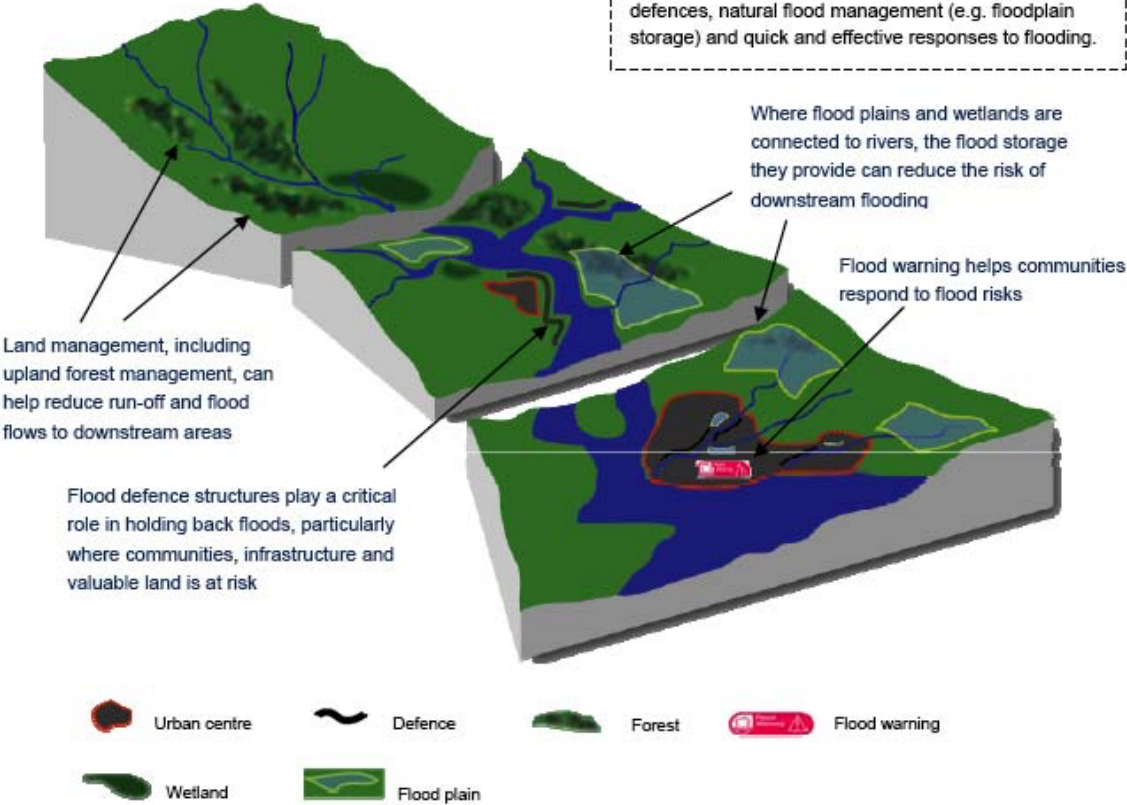
<http://www.gov.scot/Publications/2011/06/15150211/9>

Sustainable Flood Management

Sustainable flood management is an approach to planning and delivering measures to reduce flood risk.

Increasing resilience to flood risk is an important component of sustainable flood management. Resilience to flooding can be increased through a variety of measures, including flood warning, flood defences, natural flood management (e.g. floodplain storage) and quick and effective responses to flooding.

REMEMBER
Protect,
Reconnect,
Restore
Sustain

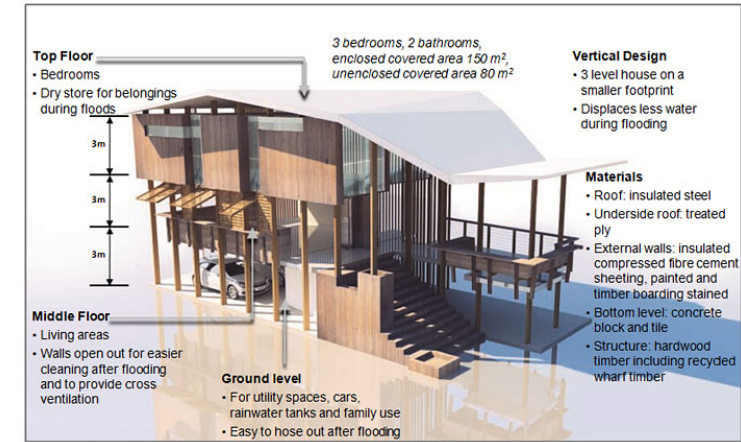


LANDUSE PLANNING & DESIGN

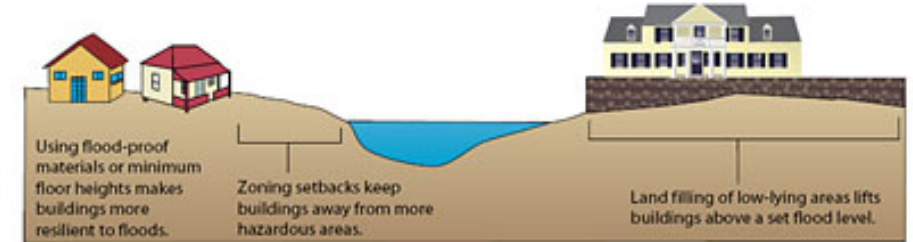


<http://www.wstuk.com/surveys-data-management>

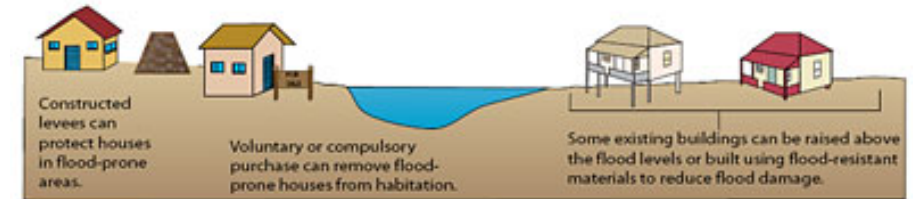
<http://www.chiefscientist.qld.gov.au/publications/understanding-floods/managing-flood-risks>



New development areas



Existing development areas



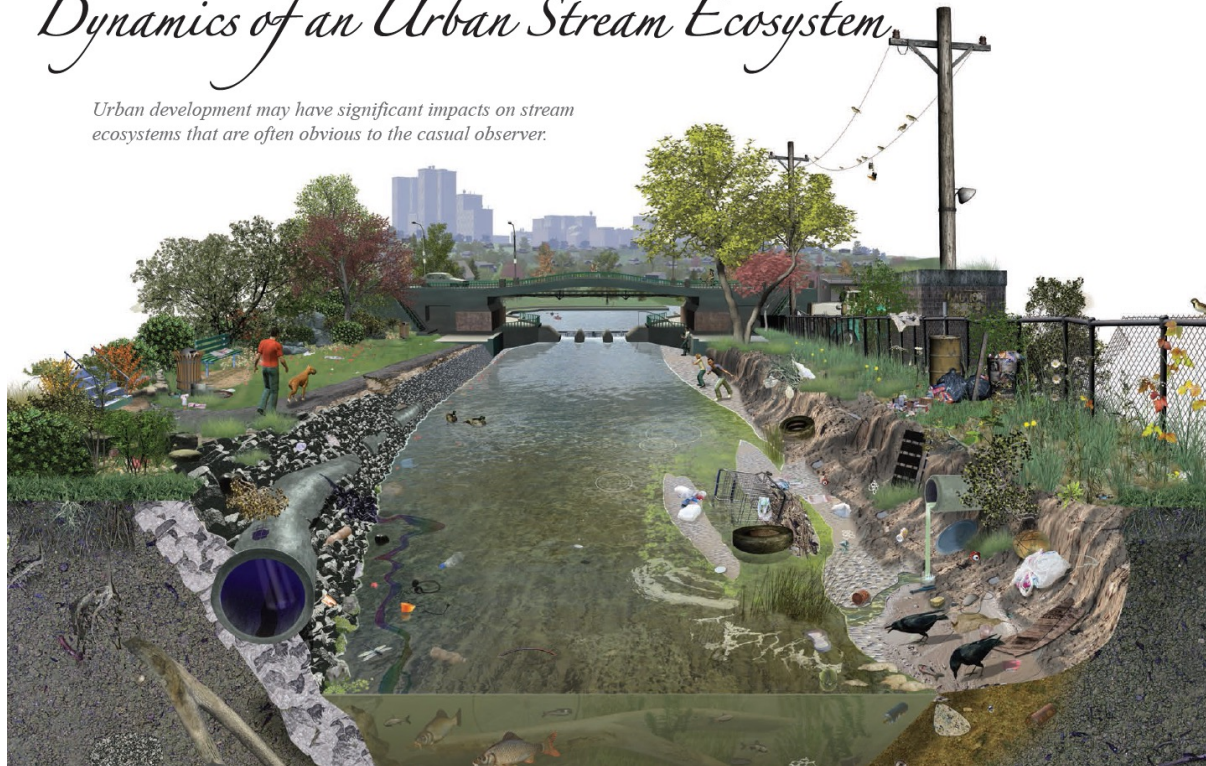
Pollution

“In natural freshwater environments water quality is maintained through environmental processes. Nutrients are recycled through food chains and sediments filtered and diluted by vegetation and natural flows. Aquatic species are adapted to cyclical changes in water flows, food supplies and temperatures and can adapt to natural events such as droughts.”

SOURCE: Macmillan GeoWorld 10 NSW Chapter 5. Inland water

Dynamics of an Urban Stream Ecosystem

Urban development may have significant impacts on stream ecosystems that are often obvious to the casual observer.



<https://water.usgs.gov/nawqa/ecology/pubs/cir-1391/images/NaturalStream.pdf>

5 minute video

Impacts of urbanisation on stream ecosystems

“Part one of a three part series on how development can have negative effects on streams in urban and suburban areas. As a watershed becomes covered with pavement, sidewalks, and other types of urban land cover, stream organisms are confronted with an increased volume of storm water runoff, increased exposure to fertilizers and pesticides, and dramatic changes in physical living spaces within the stream itself.”

<https://www.usgs.gov/media/videos/effects-urbanization-stream-ecosystems-extended-part-i-introduction>

Stream Ecosystems Change With Urban Development

Natural Stream Ecosystem

The healthy condition of the physical living space in a natural stream—defined by unaltered hydrology (streamflow), high diversity of habitat features, and natural water chemistry—supports diverse biological communities with aquatic species that are sensitive to disturbances.



Drawing by Frank Ippolito, Production Post Studios, 110 North Feltus St., Bloomfield, N.J.

Natural Stream Ecosystem

What is a stream ecosystem? A stream ecosystem is defined by the hydrology, habitat, and chemistry conditions and the biological communities within the stream, all of which are influenced by activities in the surrounding watershed. A complex and well-balanced ecosystem provides recreation, aesthetics, food, water, nutrients, and many other valuable assets to humans, animals, and plants that live in the area. Natural stream ecosystems are well adapted

to seasonal environmental changes, such as annual flooding and drought cycles.

Every stream is connected downstream to other water bodies including rivers, reservoirs, and ultimately coastal waters. Inputs of chemical contaminants or sediments at any point along the stream can cause degradation downstream with adverse effects on biological communities and on economically valuable resources, such as fisheries and tourism.

Urban development is associated with changes in the natural environment such as alterations to the hydrology, habitat, and chemistry of a stream, which result in stressors to biota in stream ecosystems. Impervious surfaces, such as parking lots, roads, and rooftops, limit the amount of rainwater seeping into the ground, which increases stormwater runoff. Urban areas often experience a rapid rise in streamflow after a rainfall, which can erode streambanks and bottoms and

degrade fish spawning and feeding habitats. Stream channels are often reinforced with concrete or large rock to minimize erosion and control flooding. Water temperature increases when tree cover is removed along the banks, thus exposing the stream to more sunlight. Chemicals, wastes, and sediment—from industry, animal production, water treatment, and runoff from impervious surfaces—increase in the stream and can be toxic to biological communities. Biological communities have different

life cycles and requirements for food, shelter, and reproduction; consequently, their responses also vary with changes in physical and chemical conditions related to urban development. Understanding how algal, invertebrate, and fish communities respond to physical and chemical stressors associated with urban development can provide important clues on how multiple stressors can be managed to protect stream health as a watershed becomes increasingly urbanized.

National Water-Quality Assessment Program

Urban Stream Ecosystem

In a highly degraded urban stream, the poor condition of the physical living space—streambank and tree root damage from altered hydrology, low diversity of habitat, and inputs of chemical contaminants—contributes to biological communities with low diversity and high tolerance to disturbance.



Drawing by Frank Ippolito, Production Post Studios, 110 North Feltus St., Bloomfield, N.J.

Urban Stream Ecosystem

The healthy condition of the physical living space in a natural stream—defined by unaltered hydrology (streamflow), high diversity of habitat features, and natural water chemistry—supports diverse biological communities with aquatic species that are sensitive to disturbances.

In a highly degraded urban stream, the poor condition of the physical living space—streambank and tree root damage from altered hydrology, low diversity of habitat, and inputs of chemical contaminants—contributes to biological communities with low diversity and high tolerance to disturbance.

<https://pubs.usgs.gov/gip/143/pdf/GIP143.pdf>

Natural Stream Ecosystem Hydrology, Habitat, Chemistry Conditions



Rainfall gradually reaches a stream in a natural or undeveloped setting by flowing over the land surface into the stream and by seeping into the soil and flowing underground (as groundwater) toward the stream. These natural seasonal patterns of hydrology, together with seasonal changes in light and temperature, serve as life cycle cues to a biological community.

Stream habitat is the physical living space of aquatic biota and includes the channel size and shape, water depth and velocity, and structures within the stream, such as woody debris and boulders. Slow moving, deeper areas of a stream are called pools, and faster flowing shallow areas are referred to as riffles. A natural stream with multiple habitats generally will have a diverse biological community.

Some chemicals and nutrients, such as nitrogen and phosphorus, are required for all stream life. Nutrients are incorporated into algae, which are then consumed by other biota, such as invertebrates and fish, thus introducing the nutrients into the aquatic food web. Oxygen dissolved in water is essential for all biological communities, and adequate amounts of oxygen are necessary to support a diverse biological community.

Videos, podcasts, articles, and fact sheets describing the USGS assessment of the effects of urban development on stream ecosystems in nine metropolitan areas of the United States are available at <http://water.usgs.gov/hawa/urban/>.



U.S. Department of the Interior
U.S. Geological Survey

Natural Stream Ecosystem Biological Communities



Fish have life cycles that can span years and are affected by stream hydrology, habitat, and chemistry, and other biological communities. Fish are relatively mobile along the stream as they search for food. Smallmouth bass can hide under logs or undercut banks along stream edges or in pools, and emerge to feed on crayfish and small fish. Greenside darters live in riffle habitats of streams, where they feed on aquatic invertebrates, such as dragonfly larvae.

Invertebrates have complex life cycles that occur over time spans of weeks to years. Most aquatic insects spend nearly all their life in the water as eggs and larvae, and then leave the water and develop wings as adults. This dragonfly larva lives in areas of slower streamflow, where it preys on other invertebrates and even some small fish. Many species of dragonflies are sensitive to pollution, as are mayflies and stoneflies. These invertebrates crawl on the surfaces of rocks and feed by gathering and shredding leaf debris, scraping off algae, or preying on other insects.

Algae, such as these diatoms, are microscopic plants and are the foundation of aquatic foodwebs. Algae have short life cycles of days to weeks, and they can respond rapidly to changes in sunlight, water chemistry, and streamflow. The most common algae reported in natural streams of small-to-moderate size are diatoms, which attach to underwater surfaces, such as rocks and aquatic plants. *Cymbella* is found in riffles, while *Epithemia* is found in both pools and riffles.

Urban Stream Ecosystem Hydrology, Habitat, Chemistry Conditions



Urban development in a watershed alters the hydrology or movement of water through a watershed. As the amount of impervious surface and artificial drainage systems (for example, storm drains) increases with urban development, stormwater runoff from developed sites occurs more quickly. The higher streamflows that often result can alter stream channels through streambank erosion and can increase the magnitude of seasonal floods to a level that damages homes and property near the stream and in the flood plain.

Urban development can alter habitats that provide living spaces for the biota in and around the stream. Plants and trees near a stream can be removed to increase the amount of light reaching streams, and cement or rock can be added to the channel to protect it from high streamflow. Sediment from erosion can fill spaces between rocks on the stream bottom, thus reducing living space or habitat for the biological communities.

Urban development might increase the inputs of chemicals to levels that greatly exceed those that occur naturally in streams and can be toxic to the biological communities. For example, excess amounts of nutrients from fertilizers and runoff from lawns can lead to an abundance of algae and might result in extreme high and low levels of dissolved oxygen in a stream. Pesticides from lawn care or insect control and heavy metals from industry and vehicles can be ingested or absorbed by the biological communities.

Urban Stream Ecosystem Biological Communities



Native fishes that are sensitive to changes in the stream ecosystem generally become less abundant with increased urban development, while tolerant species, such as fathead minnow, although native to streams in the United States, tolerate muddy, low-oxygen water that is typical of many urban streams. Fish that are more tolerant to urban stressors are often non-native species, such as the common carp, that prefer slow or still water and silt stream sediments.

Urban development leads to a loss of invertebrate species that are sensitive to pollution, such as mayflies and stoneflies, and an increase in more tolerant species, such as leeches and isopods. The loss of species that are sensitive to pollution can begin at very low levels of urban development. Tolerant species, such as leeches and isopods, are most common in warm, protected shallow areas of streams. Leeches prefer slower moving streams with relatively low dissolved oxygen levels.

An increase in urban development often results in a high abundance of algae that are tolerant of pollution. Diatom algae tend to decrease and non-diatom algae tend to increase with urban development. Some non-diatom algae, such as green or blue-green algae that appear as a green coating on the surface of the water and rocks, are in low abundance in natural streams but might increase in abundance to nuisance levels from open sunlight and nutrient-rich conditions in many urban streams.

By Amanda H. Bell, James F. Coles, and Gerard McMahon

General Information Product 143
October 2012

PRINT THIS POSTER AS AN A3 SIZED PLACEMAT RESOURCE

Drivers of change to water quality

Pollution, land (habitat) clearing, water extraction, invasive species and climate change contribute to declining freshwater quality.

Cultural eutrophication – increased nutrient loads (Nitrates, Phosphates) from industrial waste, agricultural run-off and human waste cause algal blooms that block light, deplete oxygen levels and create dead zones.

Bioaccumulation –toxic substances build up in food chains impacting on aquatic organisms and human health.

Turbidity –suspended sediment comes from increased erosion and invasive species such as Asian Carp blocks light and suffocates aquatic organisms.

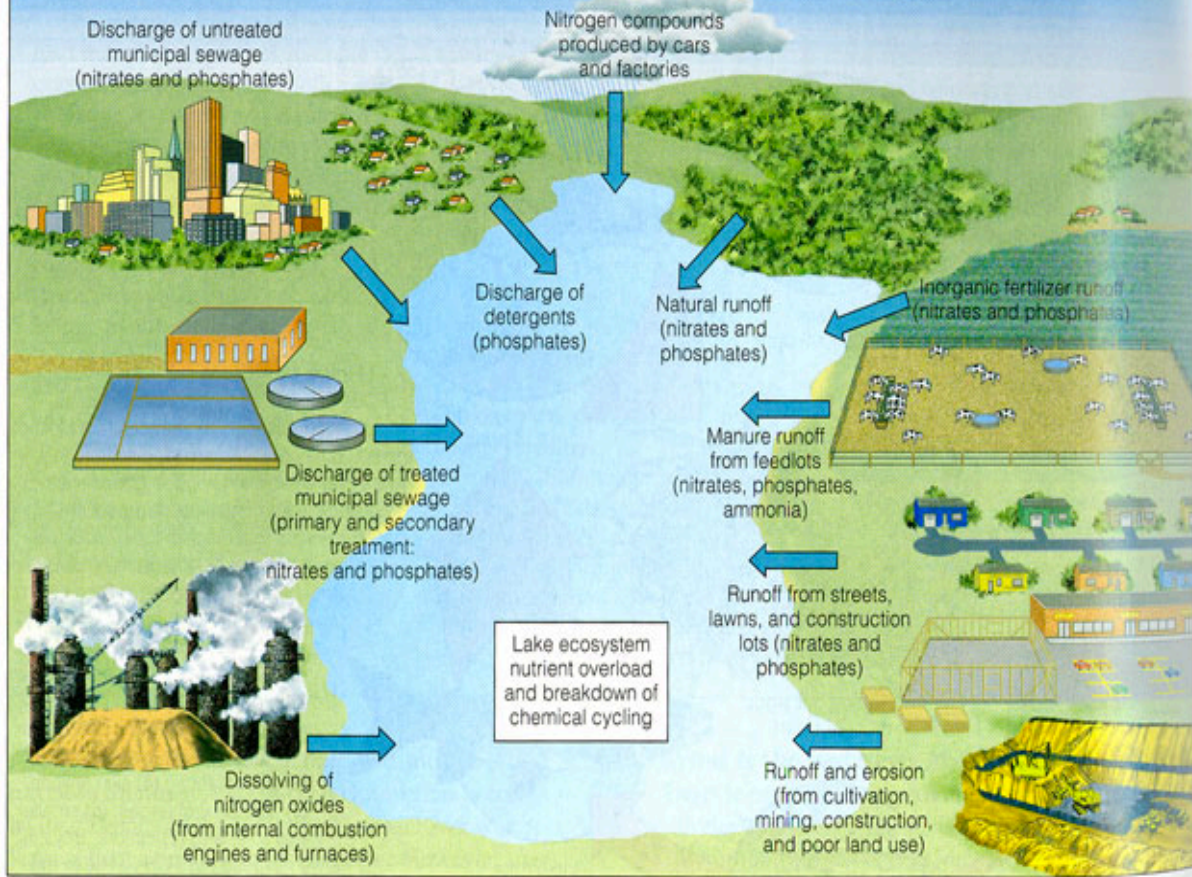
Water extraction increases nutrient concentrations and temperatures

Acidification: air pollutants such as Sulphur Dioxide dissolve in waterways increases pH (acidity) to levels lethal killing aquatic species.

Infiltration of chemicals and nutrients degrades groundwater sources

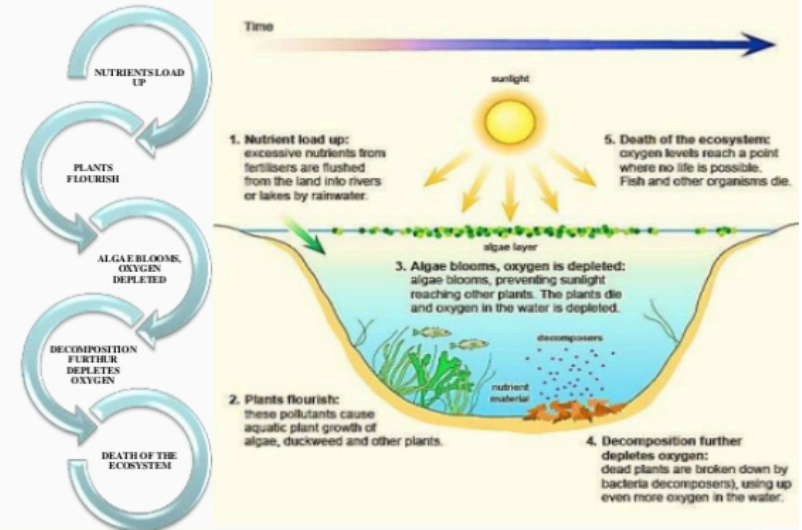
IMPORTANT CONCEPTS
Deep understanding

Sources of Cultural Eutrophication

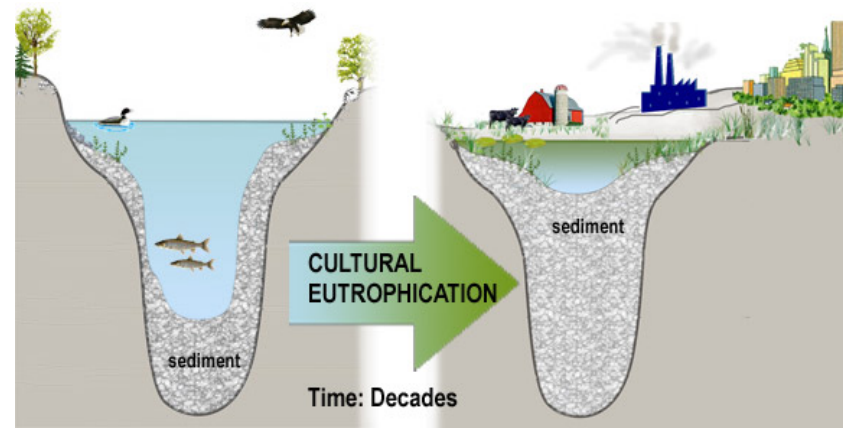


http://www.econatics.co.za/?page_id=750

Eutrophication Process in 5 Stages



<https://www.slideshare.net/PanthoSarker/eutrophication-it>



<https://creeklife.com/blog/cultural-eutrophication>

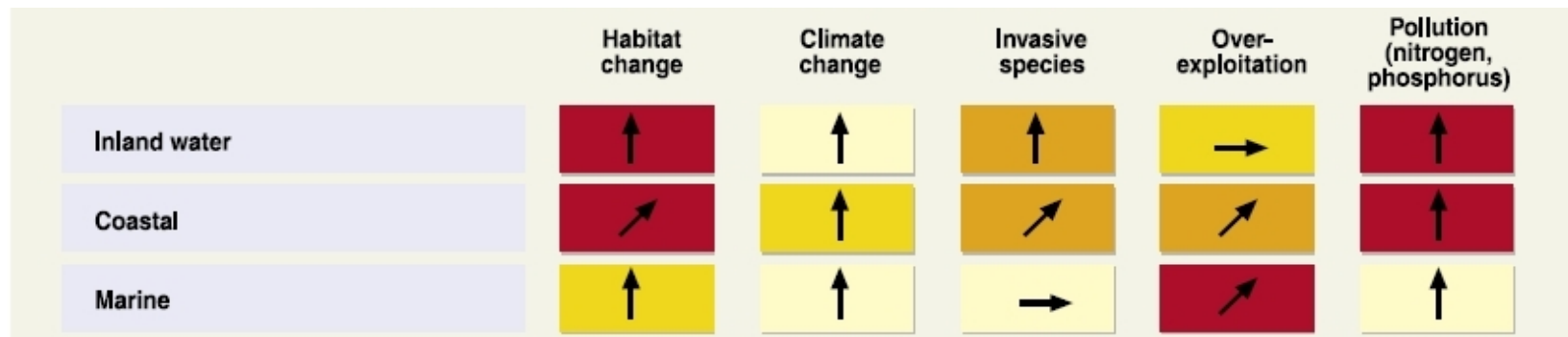
Industrial waste

“Industrialisation, commercial agriculture and urbanisation put pressure on freshwater environments in developed countries. In the USA the Mississippi River transports over 1.5 million tonnes of nitrogen from farmlands in 31 states causing algal blooms and a dead zone in the Gulf of Mexico.

In Italy, Europe’s most polluted river the Sarno suffers pollution from industrial waste from over 1200 illegal toxic waste dumping sites. Highly developed waterways in Europe such as the Danube have poor water quality”.

Source Macmillan GeoWorld 10 NSW Chapter 5

Drivers of change and trends to inland water



World Resources Institute

Macmillan GeoWorld 10 Chapter 5

River restoration

Broadly speaking river restoration is deemed necessary or worthwhile where there is a legacy of human river modification.

This modification could be direct such as dredging, or indirect such as agricultural practices increasing sediment delivery, but generally the river in question has been altered in some way from its “pre-human” state.

Previous river modification may have altered the processes within the river such that the way the river looks, behaves, or functions is not meeting societal expectations (e.g. local people, river uses, legislators, etc).

<https://therivermanagementblog.wordpress.com/2013/07/03/what-is-river-restoration/>

ROLE OF TECHNOLOGY IN RIVERINE MANAGEMENT

Satellites (GIS)

Flood risk maps

Drones

Water quality Monitoring stations

Innovations e.g. robotic fish

Artificial wetlands

Fish ladders

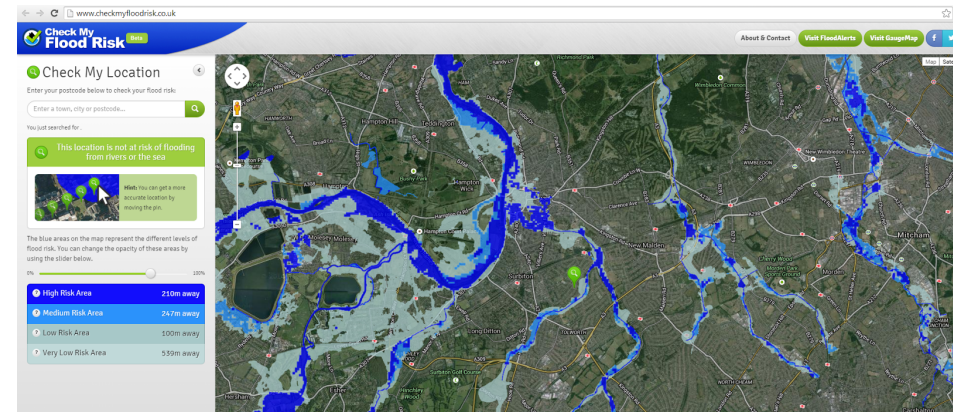


1. Robotic fish: Life-like creatures, move like real fish, have chemical sensors to find pollutants, swim independently around water bodies and automatically return when batteries need recharging



2. Floating islands: Manmade biomimic floating islands made create a “concentrated” wetland effect and a natural habitat for birds. Dense fibers and a porous texture encourage microbes – biofilm- cleaning the water and turning nutrients into fish food.

Examples from Macmillan GeoWorld 10 NSW Chapter 5



<http://mapperz.blogspot.com.au/2015/01/check-my-flood-risk-map.html>

New Zealand

<http://www.doc.govt.nz/about-us/statutory-and-advisory-bodies/nz-conservation-authority/publications/protecting-new-zealands-rivers/02-state-of-our-rivers/river-physical-processes-and-functioning/>

“Effective river management requires a holistic view of the river system, including its geology, fluvial morphology, sediment transport, biological habitat, riparian conditions, flow regime, and water quality.

Rivers are linear systems connecting headwater areas to the coast. This connectivity allows the movement of organisms, energy and matter throughout the catchment system.

Human activities can change and disrupt this system and affect river functioning:

Land disturbance in a catchment, such as cultivation, vegetation removal, and the introduction of browsing animals, can accelerate soil erosion and increase rivers’ sediment load.”

Go to Part 2 : Resources



TEXTBOOKS

Macmillan GeoWorld10 NSW Chapter 5 (Comparative: USA, Netherlands, China) pp134-160

Jacaranda GeoActive 2 Chapter 214 Inland Water pp 294-322 (Comparative : Dams)

Pearson Geography Stage 5 Chapter 11 pp. 274-302 (

Comparative s : Groundwater Great Artesian Basin / Pangani River Basin)

Cambridge Stage 5 Online Chapter Inland water

Oxford Insight Stage 5 Chapter 6 pages pp 230 – 237