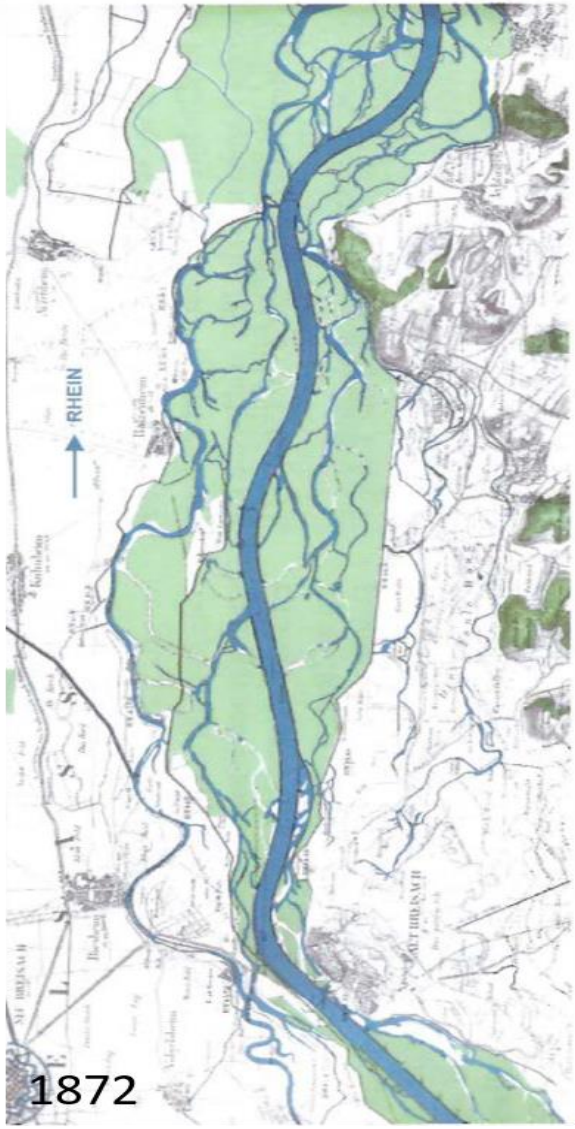
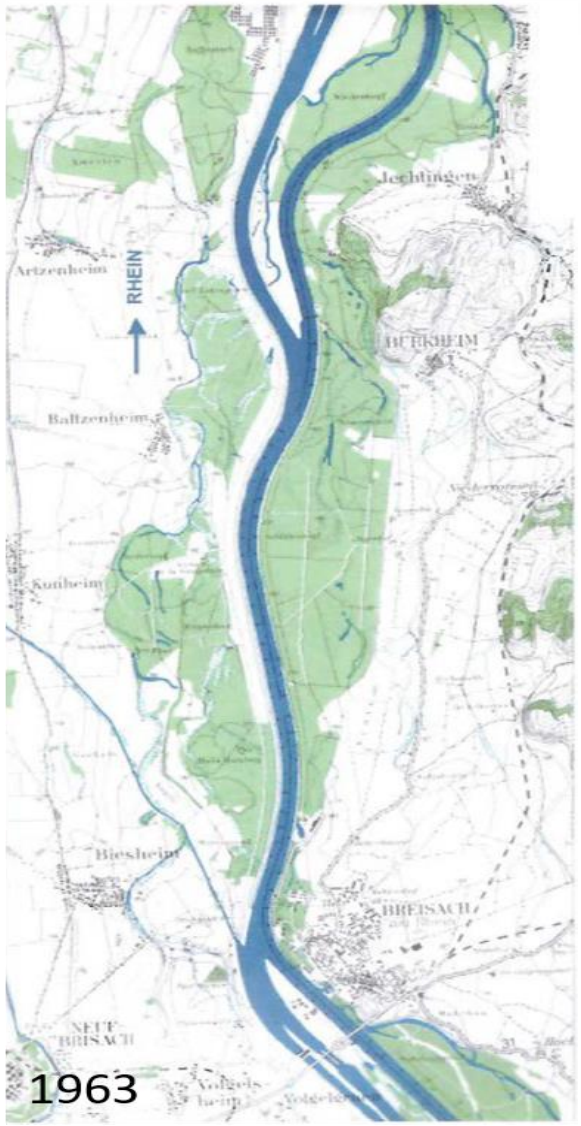
Nature-based solutions

Dr. Bregje K. van Wesenbeeck

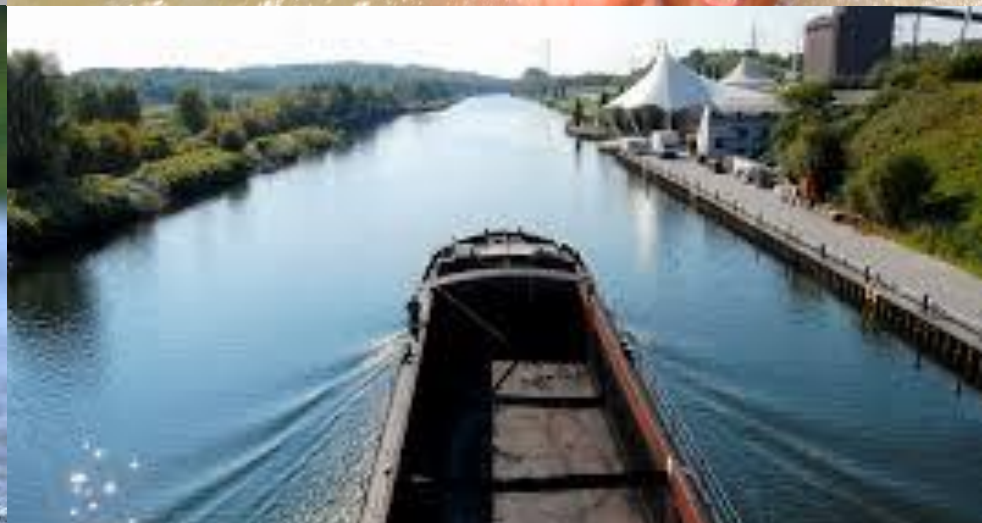
The Rhine


RHEIN
1828

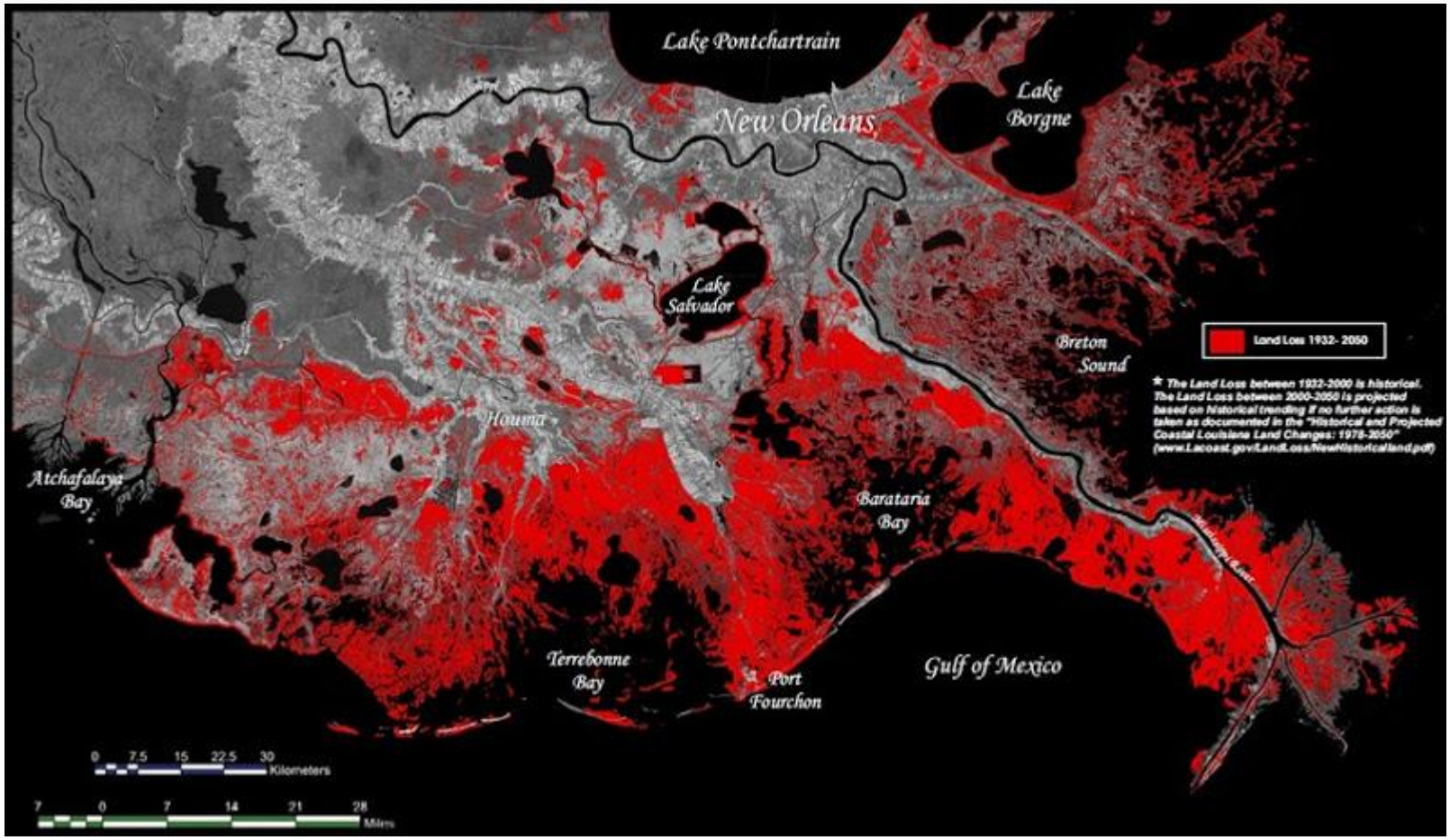

RHEIN
1872


RHEIN
Artzenheim
Jechtingen
Biesheim
BREISACH
1963

One river, many functions



River coastal linkages



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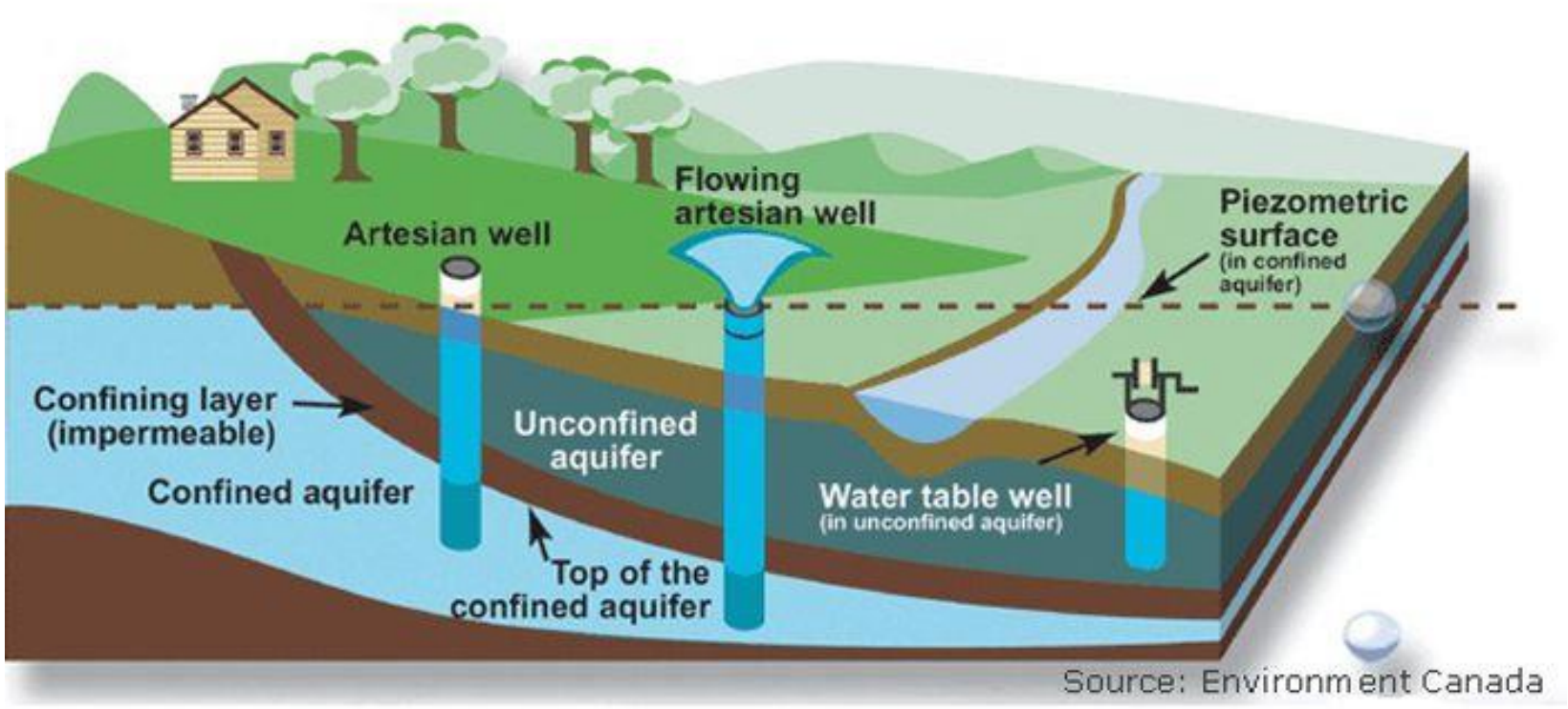
River groundwater linkages



Managing floods and droughts

Drought hits hundreds of Central Java villages - National - The Jakarta ...
www.thejakartapost.com/.../drought-hits-hundreds-of-central-java-... ▾ Vertaal deze pagina
23 jul. 2018 - A **drought** has struck hundreds of villages in Central Java, with agencies in the province sending clean water to subdistricts in Sragen, Boyolali, ...

Thousands affected by drought in Central Java without permanent ...
https://reliefweb.int/.../indonesia/thousands-affected-drought-centr... ▾ Vertaal deze pagina
15 aug. 2018 - English News and Press Release on **Indonesia** about Water Sanitation Hygiene and **Drought**; published on 15 Aug 2018 by Jakarta Post.

Drought conditions in Australia spread north as Indonesia feels the ...
www.abc.net.au/news/2018-09.../drought...indonesia/10249940 ▾ Vertaal deze pagina
19 sep. 2018 - **Drought** is also causing havoc for in **Indonesia**, with farmers struggling to raise crops and praying that rain will come soon.

(PDF) Management of Disaster Drought in Indonesia - ResearchGate
https://www.researchgate.net/.../321063992_Management_of_Disaster_Drought_in_Ind...
2 jun. 2018 - PDF | p>The **drought** disaster in **Indonesia** has occurred since 1811. It is because **Indonesia** is situated in a part of the earth with tropical ...

Drought affects millions in Indonesia, Latest World News - The New ...
https://www.tnp.sg/news/world/drought-affects-millions-indonesia ▾ Vertaal deze pagina
31 aug. 2017 - JAKARTA Millions of people across **Indonesia** are facing failed harvests and a shortage of clean water as a result of worsening **drought** ...

Natural River management

- Low interference management of rivers
- Respecting river functions and peoples' dependencies on these at a basin scale
- Optimize river use
- Reduce river related risks (droughts and floods)
- Respecting natural dynamics and flow of fresh water, sediment and nutrients

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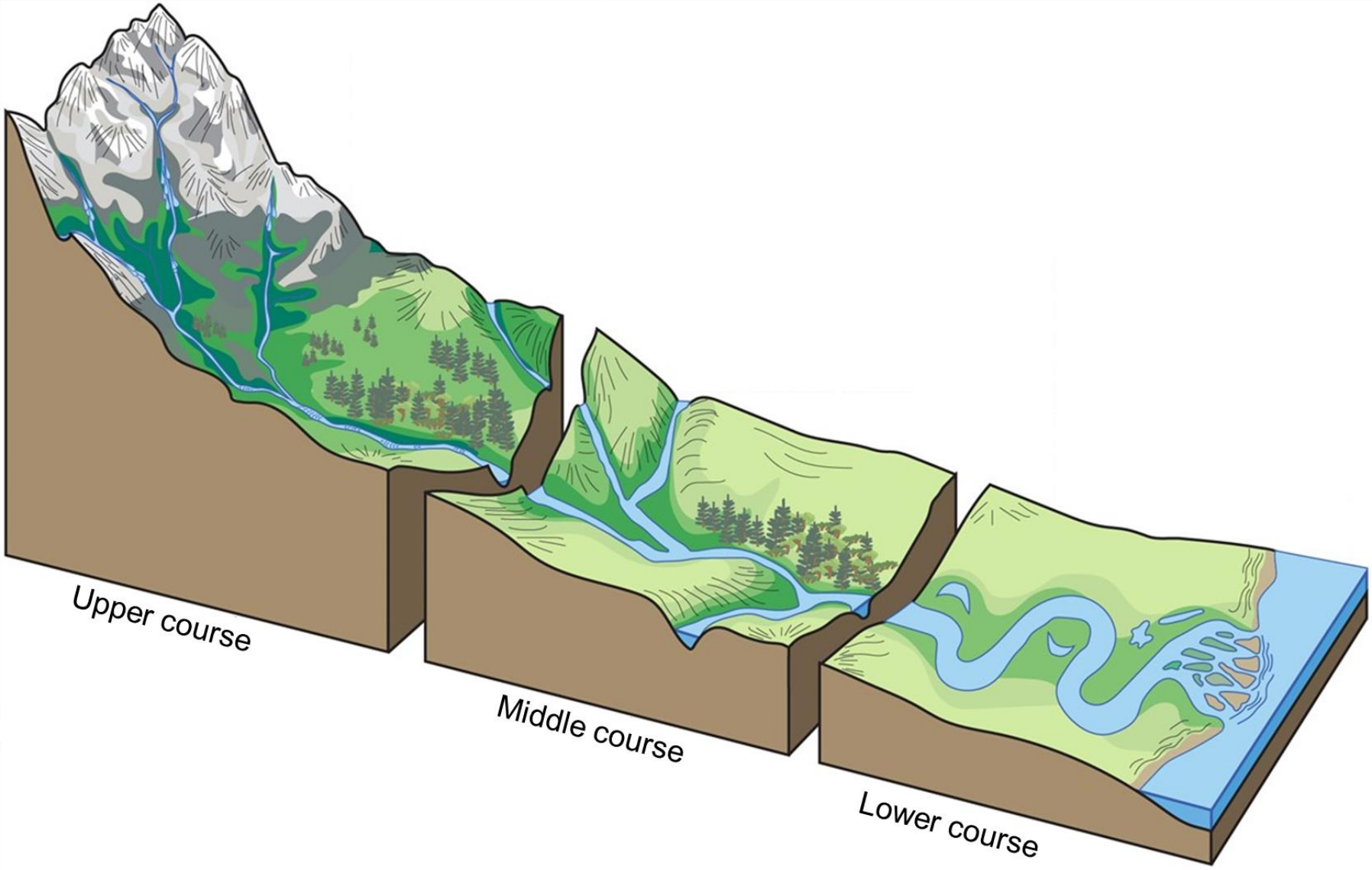
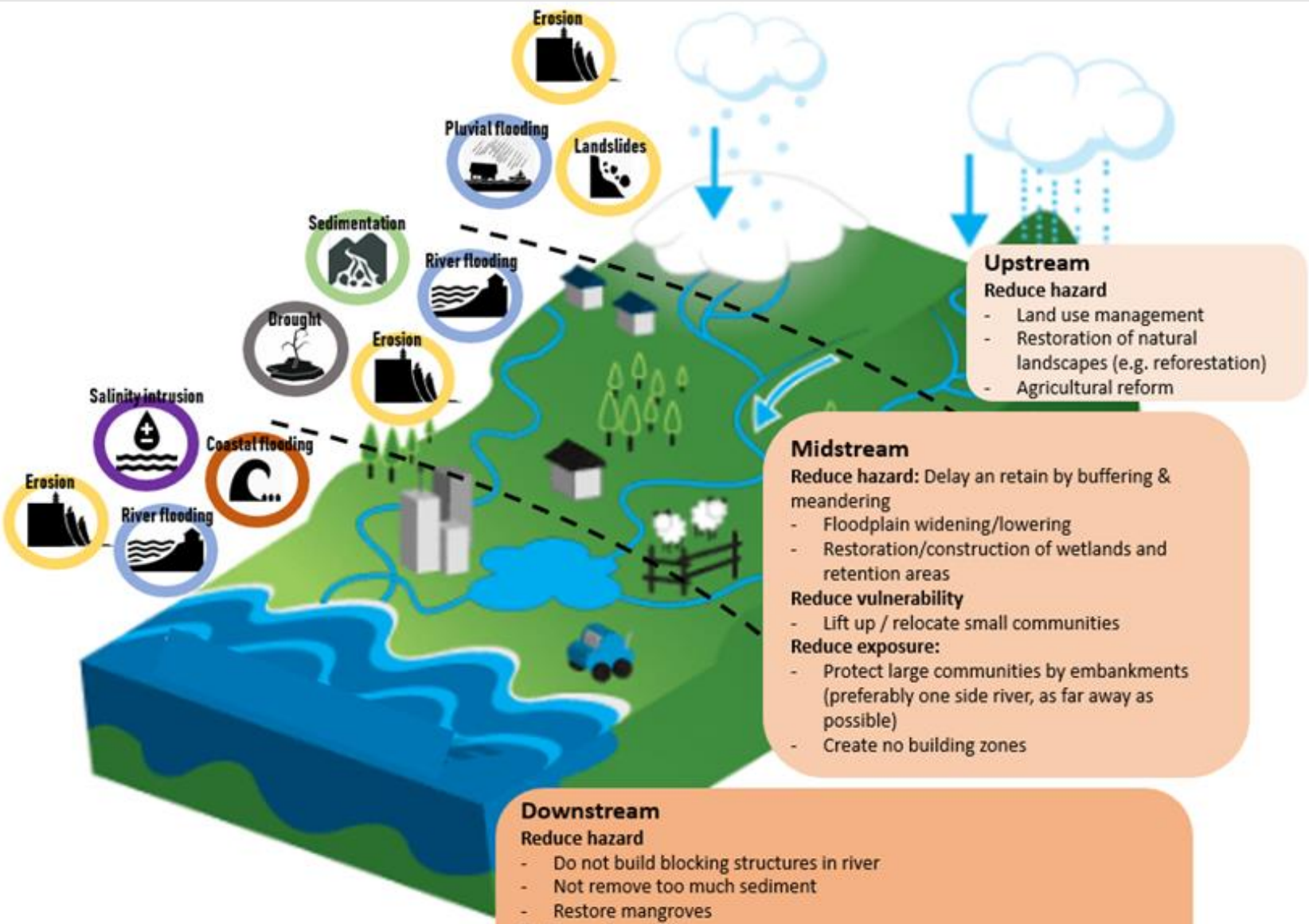
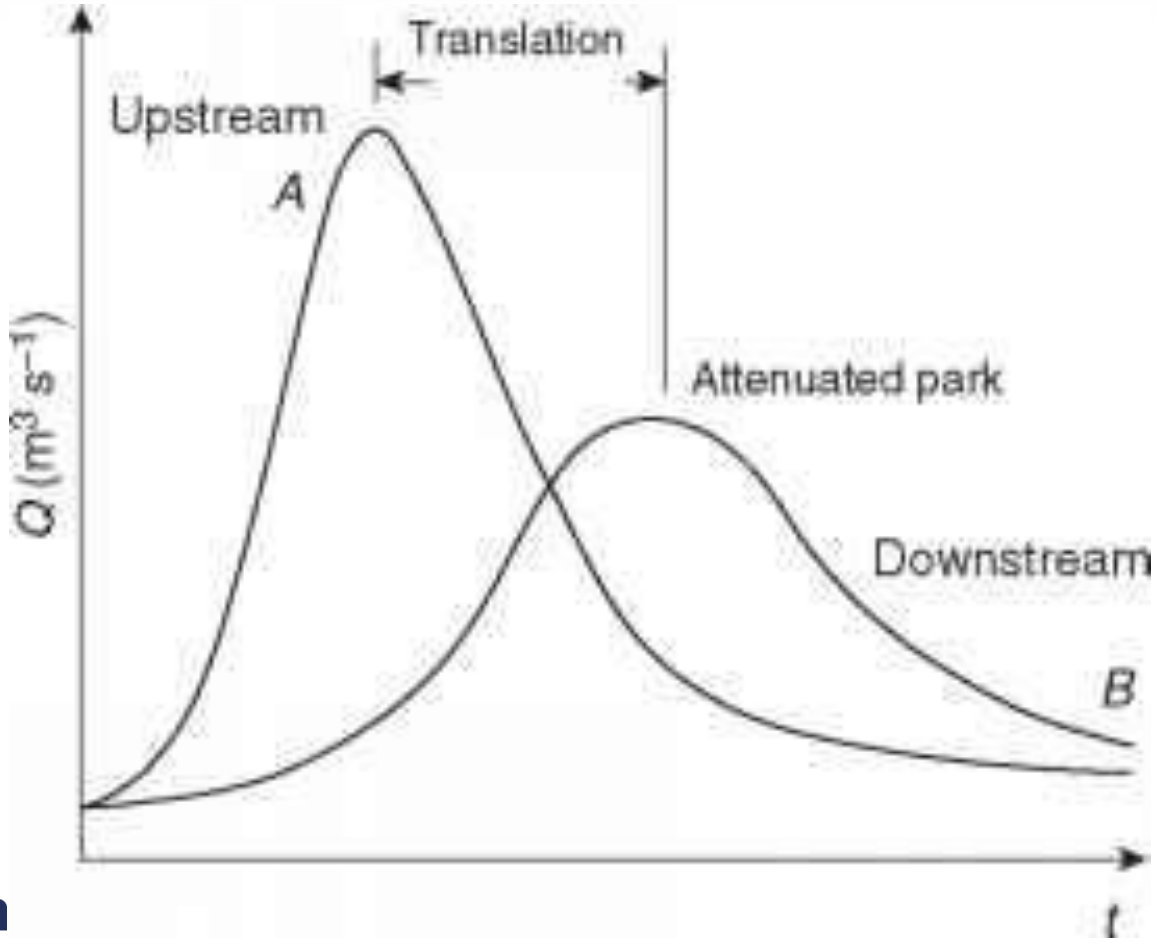
River long profile




Erosion
Pluvial flooding
Landslides
Sedimentation
River flooding
Drought
Erosion
Salinity intrusion
Coastal flooding
Erosion
River flooding
Upstream
Reduce hazard
- Land use management
- Restoration of natural landscapes (e.g. reforestation)
- Agricultural reform
Midstream
Reduce hazard: Delay an retain by buffering & meandering
- Floodplain widening/lowering
- Restoration/construction of wetlands and retention areas
Reduce vulnerability
- Lift up / relocate small communities
Reduce exposure:
- Protect large communities by embankments (preferably one side river, as far away as possible)
- Create no building zones
Downstream
Reduce hazard
- Do not build blocking structures in river
- Not remove too much sediment
- Restore mangroves
Reduce vulnerability
- Lift up / relocate small communities
Reduce exposure:
- Protect large communities by embankments (preferably one side river, as far away as possible)
- Create no building zones

River flood peak



https://www.doctorabel.us/hydrology/flood-routing.html
https://web.mst.edu/~rogersda/umrcourses/ge301/Evolving%20Laws%20for%20Flood%2

Upstream

- Land-use management
  - Reforestation (with native vegetation)
  - Terracing

Can reduce up to 50% of peak run off

Iacob et al. 2014
Sepa 2015

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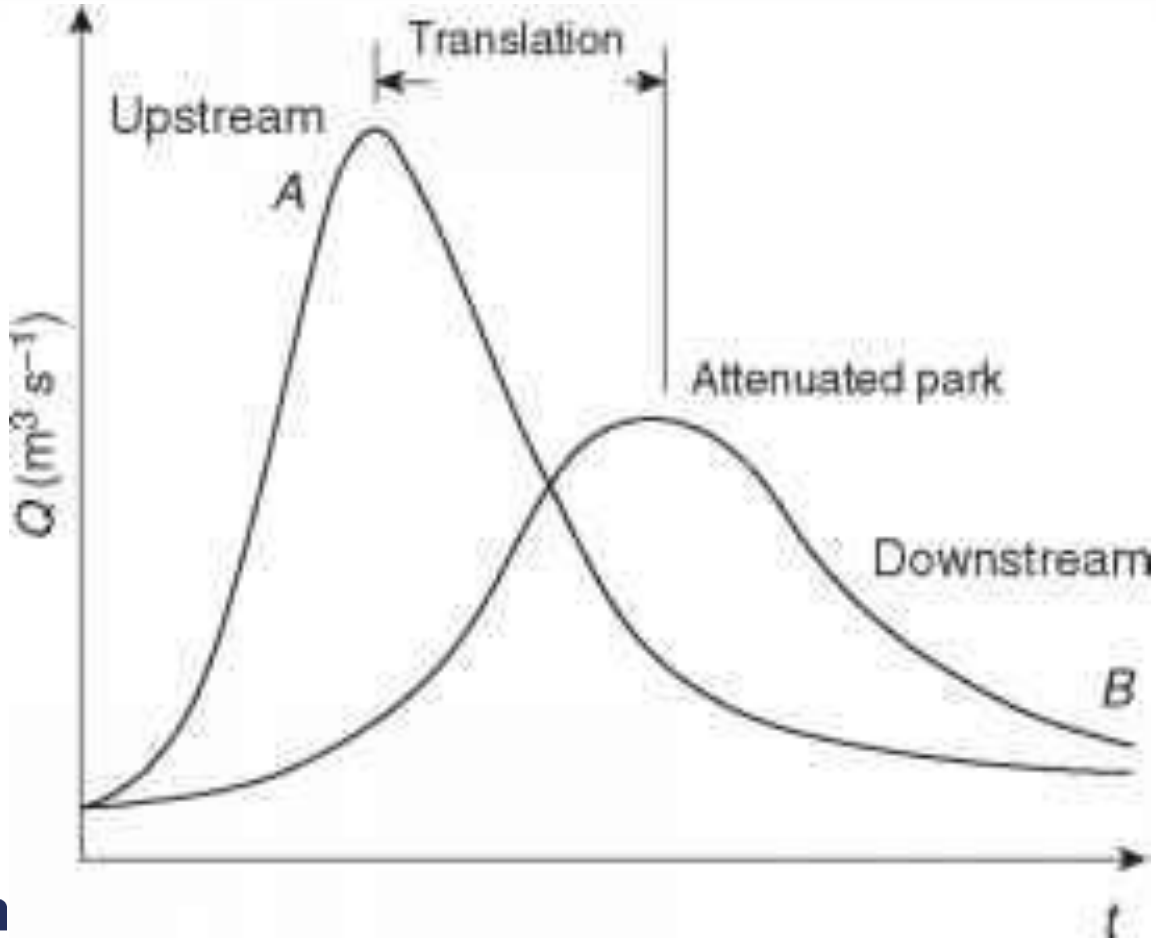
River flood peak



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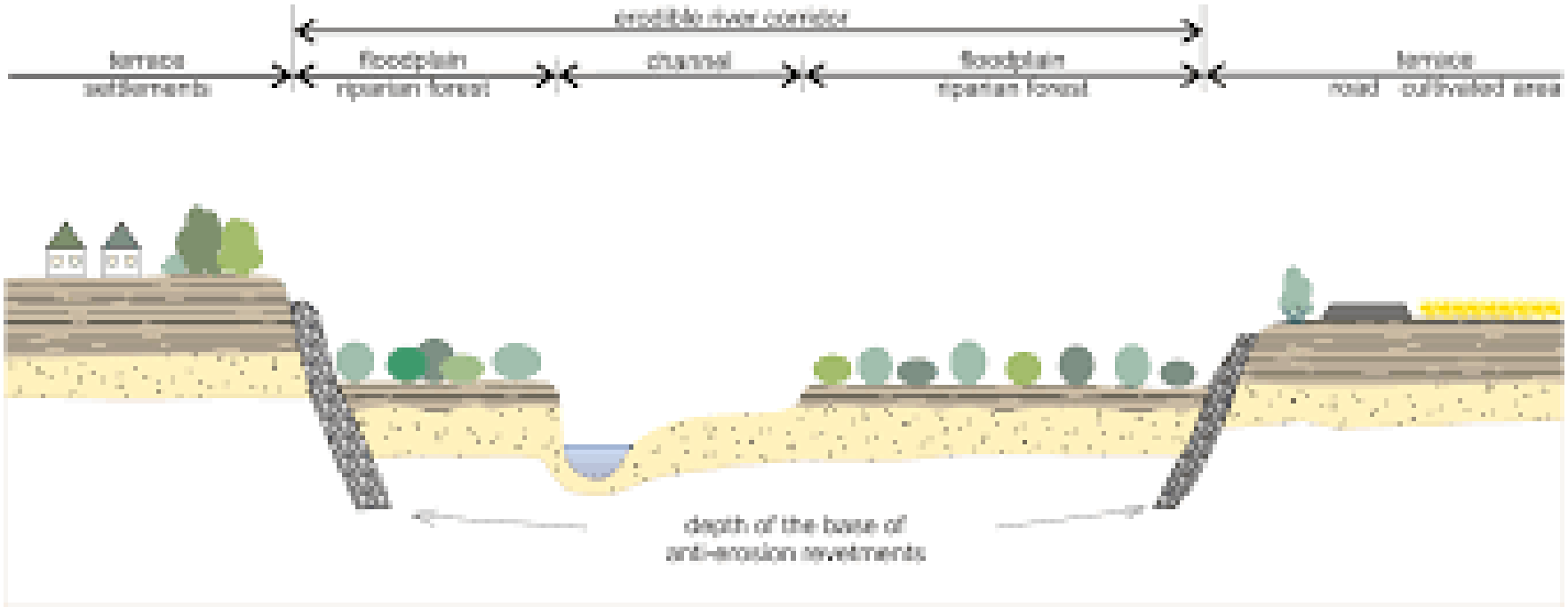
https://www.doctorabel.us/hydrology/flood-routing.html
https://web.mst.edu/~rogersda/umrcourses/ge301/Evolving%20Laws%20for%20Flood%2

Midstream and downstream

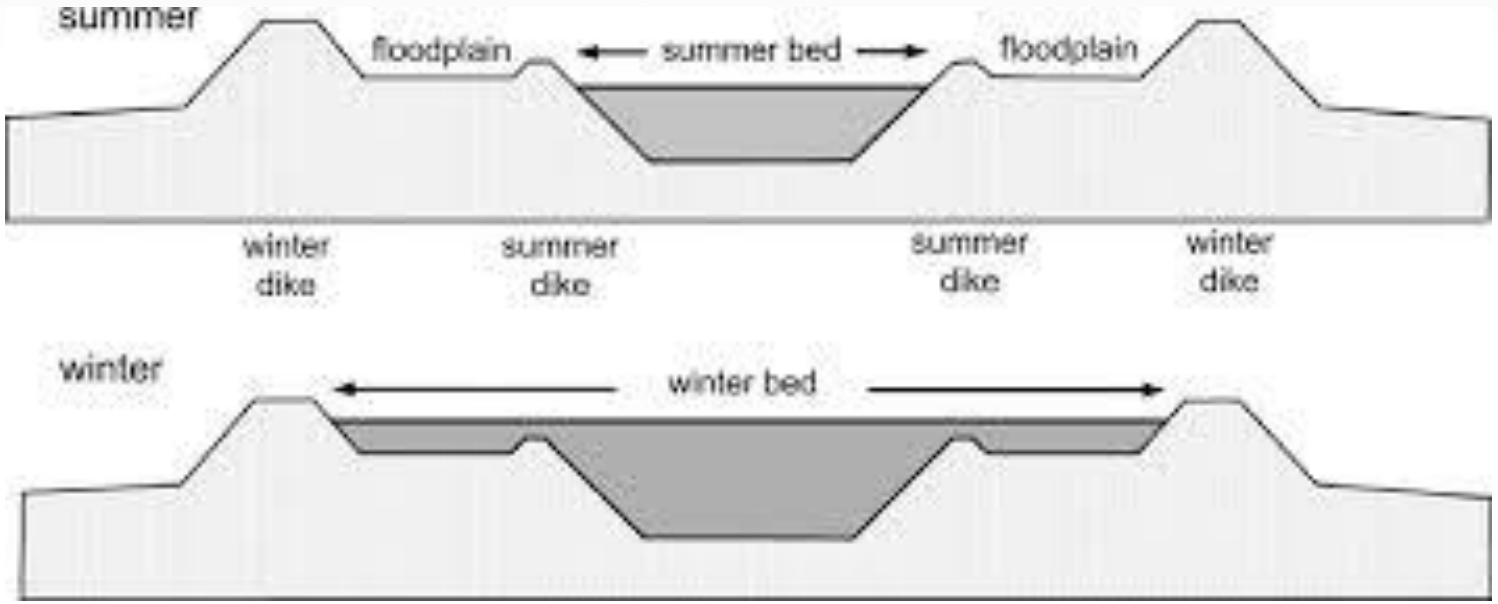
- Flood zoning
- Reconnecting flood plains
- (Re)meandering
- Conserving vegetation

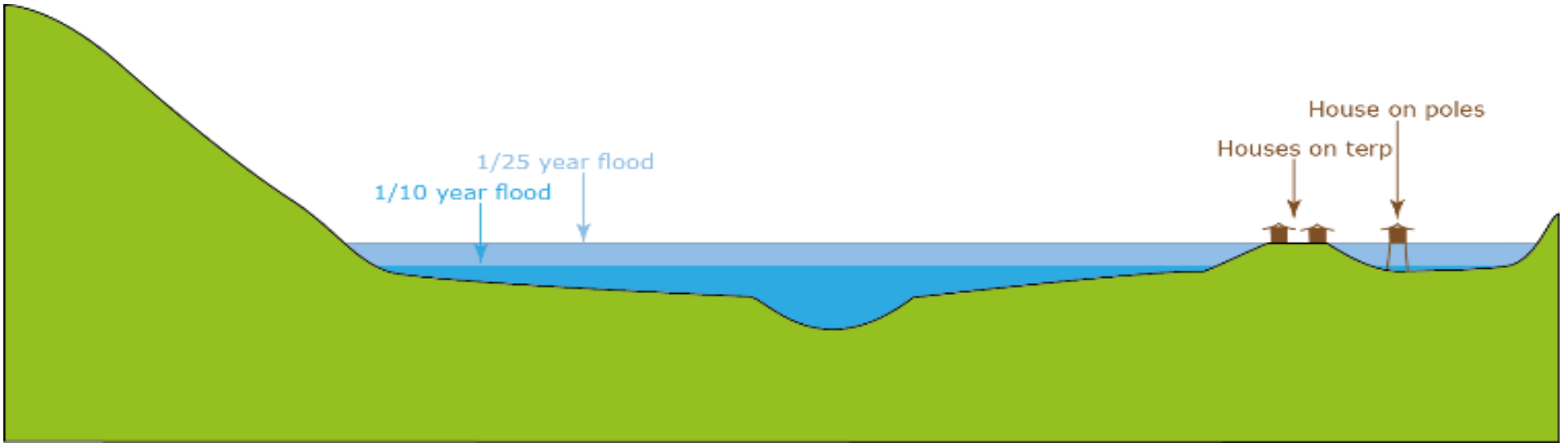
Difficult and requires space

River flood extent



Zoning


summer
floodplain
summer bed
floodplain
winter dike
summer dike
summer dike
winter dike
winter
winter bed


House on poles
Houses on terp
1/25 year flood
1/10 year flood

Room for the River

(Re)meandering

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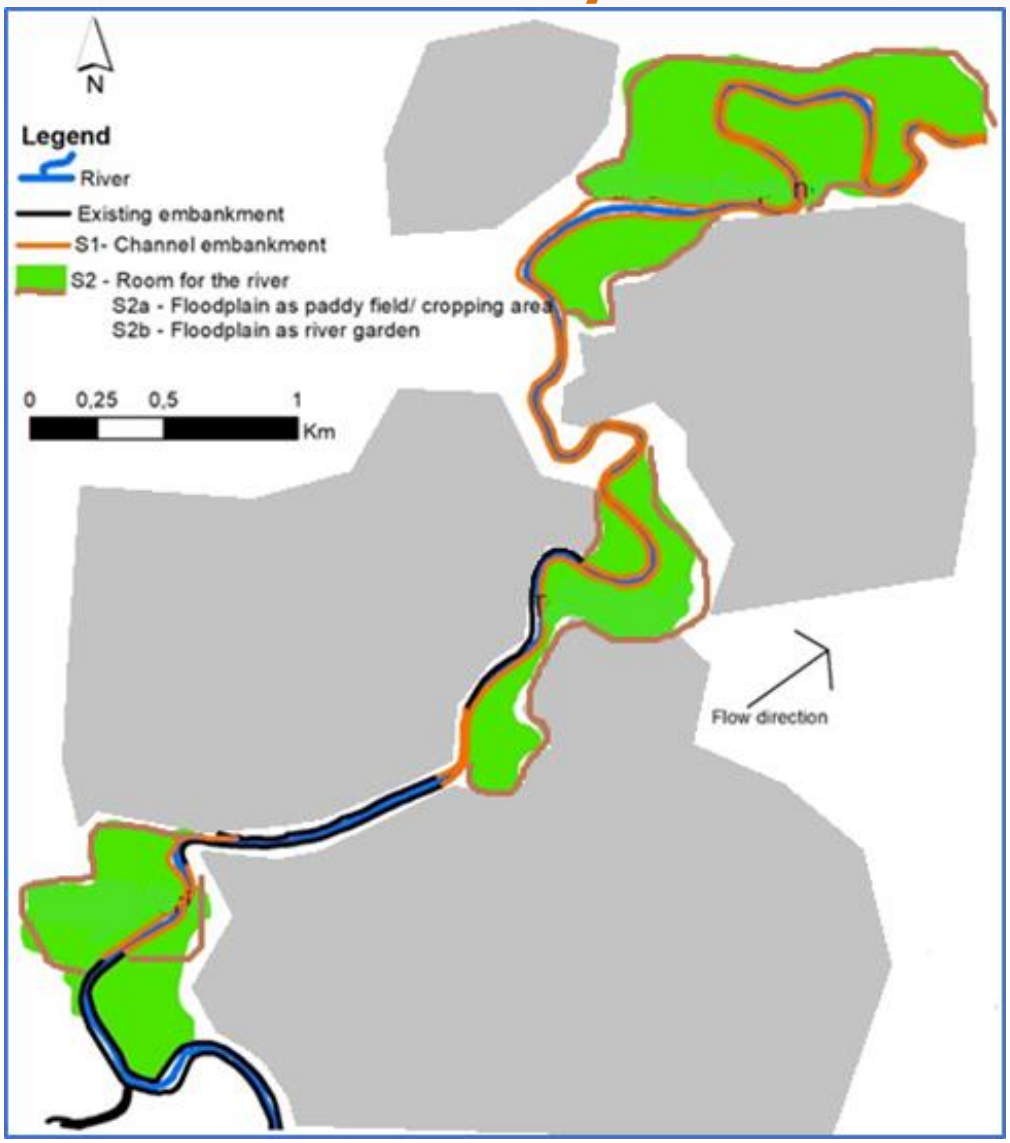
Conserving vegetation

Cimanuk –Garut city alternatives



Cimanuk –Garut city alternatives

CBA including additional benefits of NBS, lifespan 60 years

Option	grey	green	
	S1	S2a	S2b
Investment costs			
Dike construction	8	9,6	9,6
Land acquisition	1,2	1,2	21,2
Maintenance	5,7	6,9	6,9
Park construction			10,0
Total costs	**14,9**	**17,7**	**47,7**
Effects			
Flood risk reduction (project area)	22,1	22,1	22,1
Flood risk impact long-term (2050-2080)	1,3	2,6	2,6
Flood risk reduction up & downstream	-7,4	7,4	7,4
Flood risk reduction up & downstream (2050-2080)	-1,3	1,3	1,3
Flexibility flood risk stategy	-	+	+
Tourism/ recreation			5,3
Property value			2,5
Health	0	0	+
Livelihoods	0	0	+
Maintenance costs downstream embankments	-	0	0
Total benefits	**14,8**	**33,4**	**41,1**
ENPV (at DR 6%)	**0,7**	**11,5**	**-10,2**
EIRR	**6%**	**14%**	**4%**

EIRR 6% 14% 4%

Minimum CBA, lifespan 30 years

Option	grey	green	
	S1	S2a	S2b
Investment costs			
Dike construction	8,0	9,6	9,6
Land acquisition	1,2	1,2	21,2
Maintenance	5,7	6,9	6,9
Park construction			10,0
Total costs	14,9	17,7	47,7
Effects			
Flood risk reduction (project area)	22,1	22,1	22,1
ENPV (at DR 6%)	**5,9**	**3,2**	**-26,8**
EIRR	**12%**	**9%**	**-2%**

EIRR 12% 9% -2%

Not all green projects require space

Conclusions

- NBS become more valuable when adopting a longer-term and larger-scale view and when including co-benefits
- NBS requires a better understanding of the natural system, hence a longer planning and pre-feasibility phase
- NBS sometimes requires more space, but NBS on smaller scales also exists
- NBS results in more cost-effective long-term solutions for flood risk and drought problems

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Recommendations

- Inclusion of NBS in flood risk management and engineering guidelines
- Mapping available policies and incentives to accelerate NBS implementation and acceptance
- Starting some example projects
- Including NBS and natural system understanding in trainings and curriculum for engineers
- Cross institutional and departmental collaboration to facilitate NBS implementation and maintenance

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