Yuk Feng Huang (PhD, PEng, MIEM)
Univerisiti Tunku Abdul Rahman (UTAR)
Malaysia

Topic:
Flood Mitigation Measures

Natural Disaster

- A natural disaster is a natural process or phenomenon that may cause:
  - loss of life, injury or other health impacts;
  - property damage;
  - loss of livelihoods and services;
  - social and economic disruption;
  - environmental damage

- Various phenomena:
  - floods, landslides, earthquakes, volcanic eruptions, etc.

Flood Disaster

- Flood is overflow of water, which submerges land that is usually dry;
- Floods can happen in a multitude of ways:
  - when rivers overflow their banks due to excessive rain, or
  - a ruptured dam upstream, etc.
  - typhoon

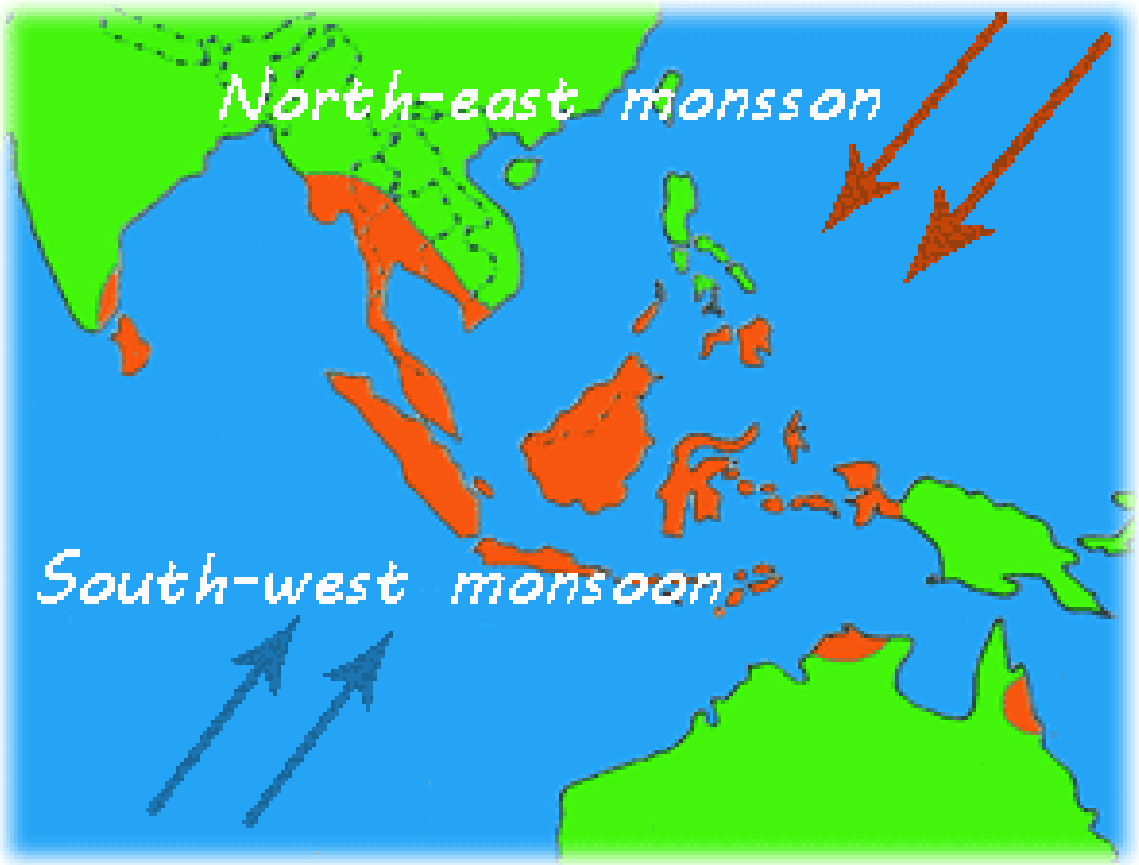
- Floods often cause damage to homes and businesses, if they are located within the **flood zones** or **floodplains**;
- In Malaysia – monsoon flood and flash floods

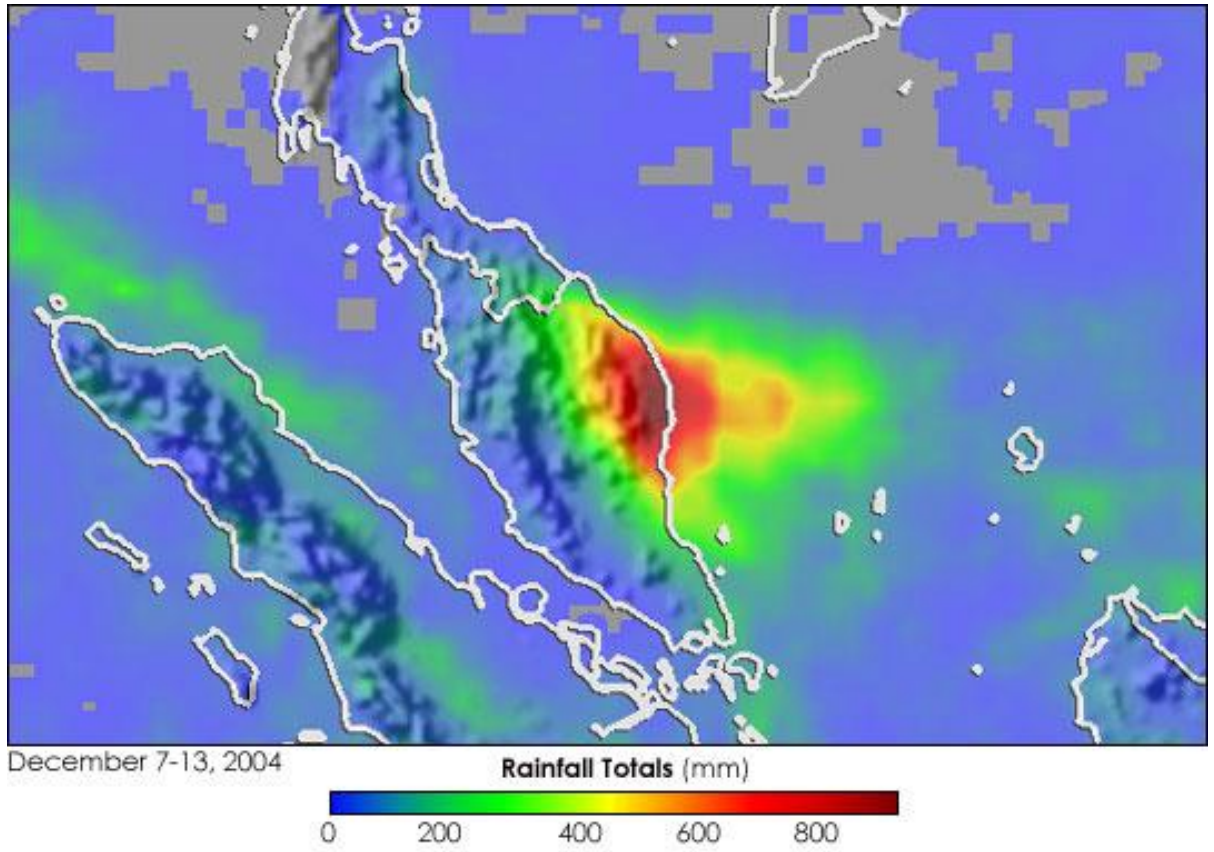

Gladstone
Ashtons
01904 659 222
HOOK
PARK GROVE
School


NC 8973 WB

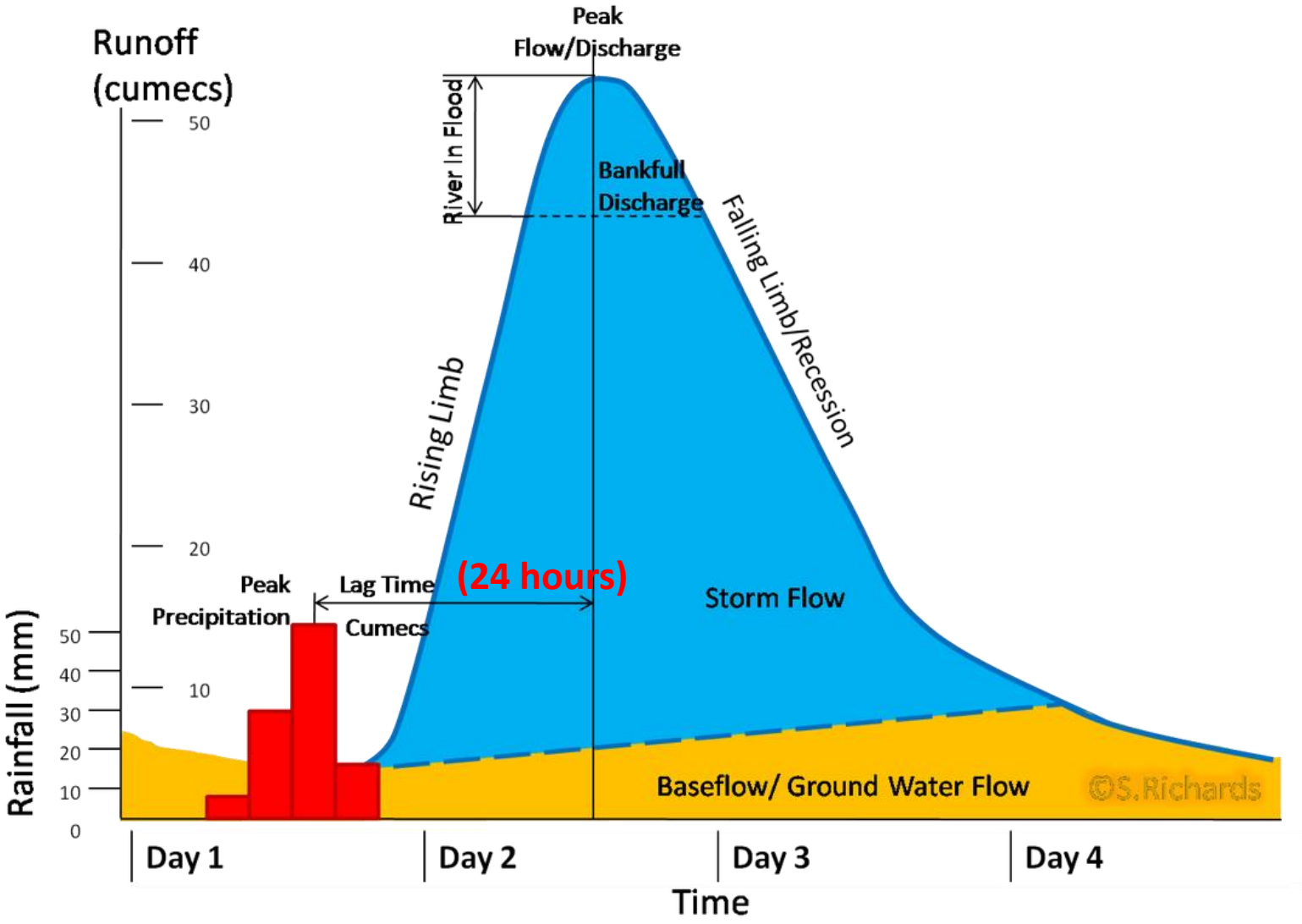

Flood

Monsoon Floods in Peninsular Malaysia

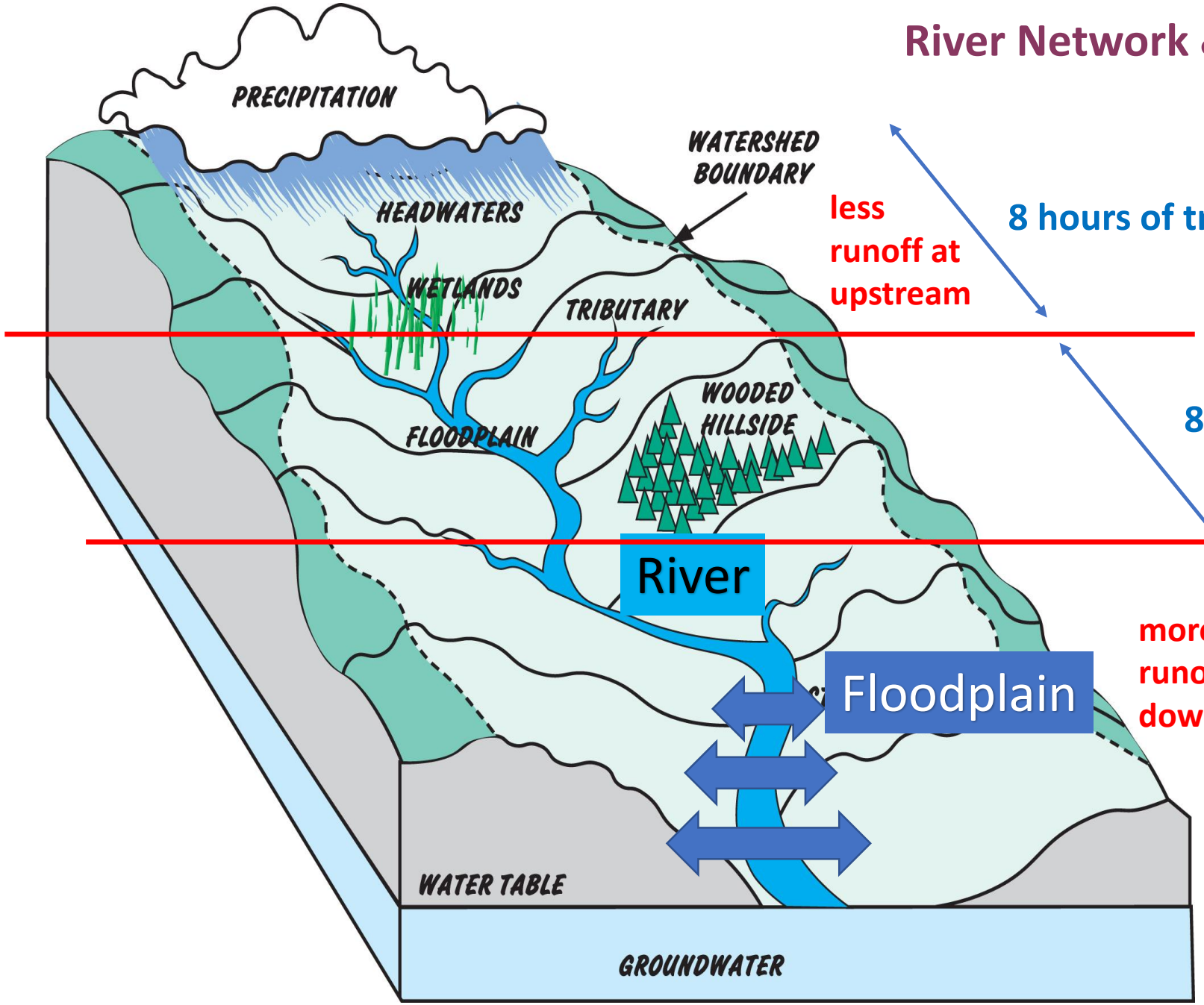




- Monsoon floods take hours or even days to develop, giving residents ample time to prepare;



River Network & Floodplain in River Basin



less runoff at upstream

8 hours of travelling time

8 hours of travelling time

8 hours of travelling time

more runoff at downstream

https://wolfriver.org/whats-a-watershed

- However, **flash floods** can be extremely dangerous, which are generated quickly and with little warning

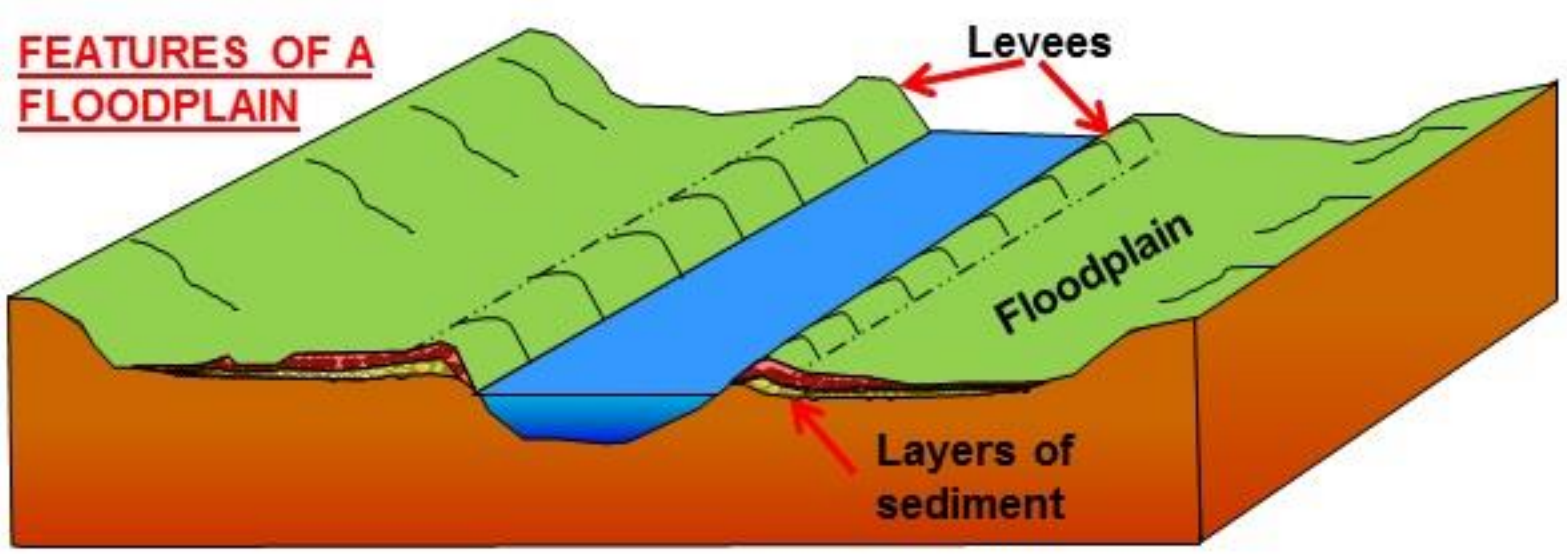
Flood Mitigation

- The prevention and mitigation of flooding can be studied on three levels:
  - individual properties;
  - small communities, and
  - whole towns or cities

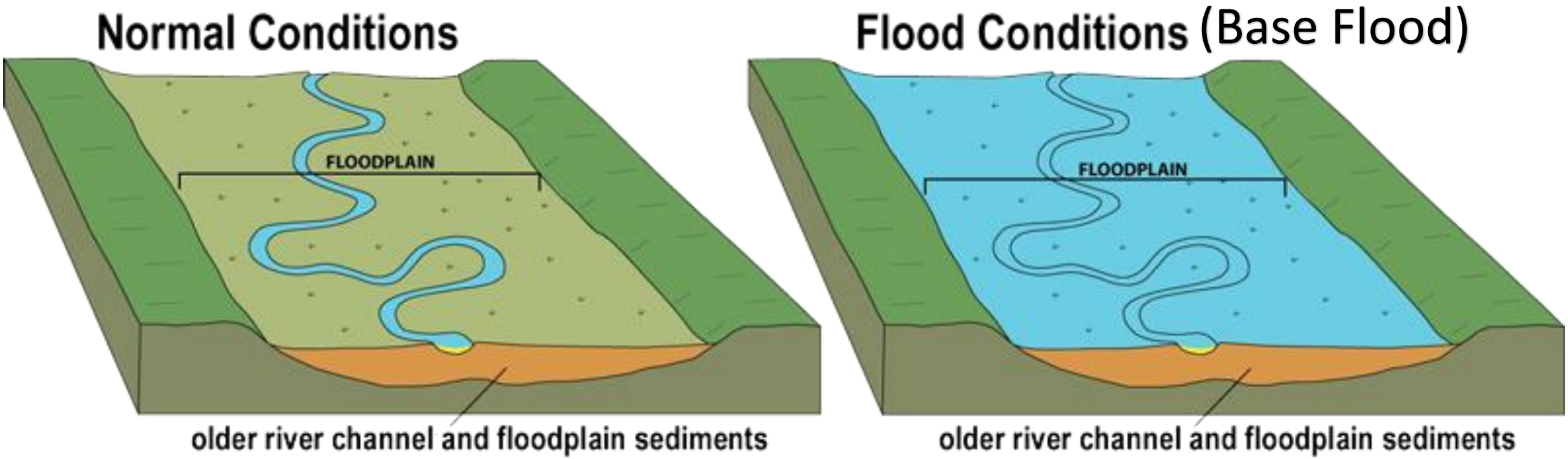
- Flood mitigation involves the management and control of flood water movement due to a rainfall event
- To mitigate floods, first we must identify the locations of **floodplain**, and then **design the floodplain (flood frequency)**

Floodplain:

- A **floodplain** is an area of land adjacent to a river, which stretches from the river banks to the base of the enclosing valley walls and experiences flooding during periods of high river flow due to heavy rain



http://www.coolgeography.co.uk/GCSE/AQA/Water%20on%20the%20Land/Meanders/Landforms%20Meanders.htm



https://www.peachtreecornersga.gov/government/public-works/stormwater/floodplain-management

Floodplain Design (Flood Frequency):

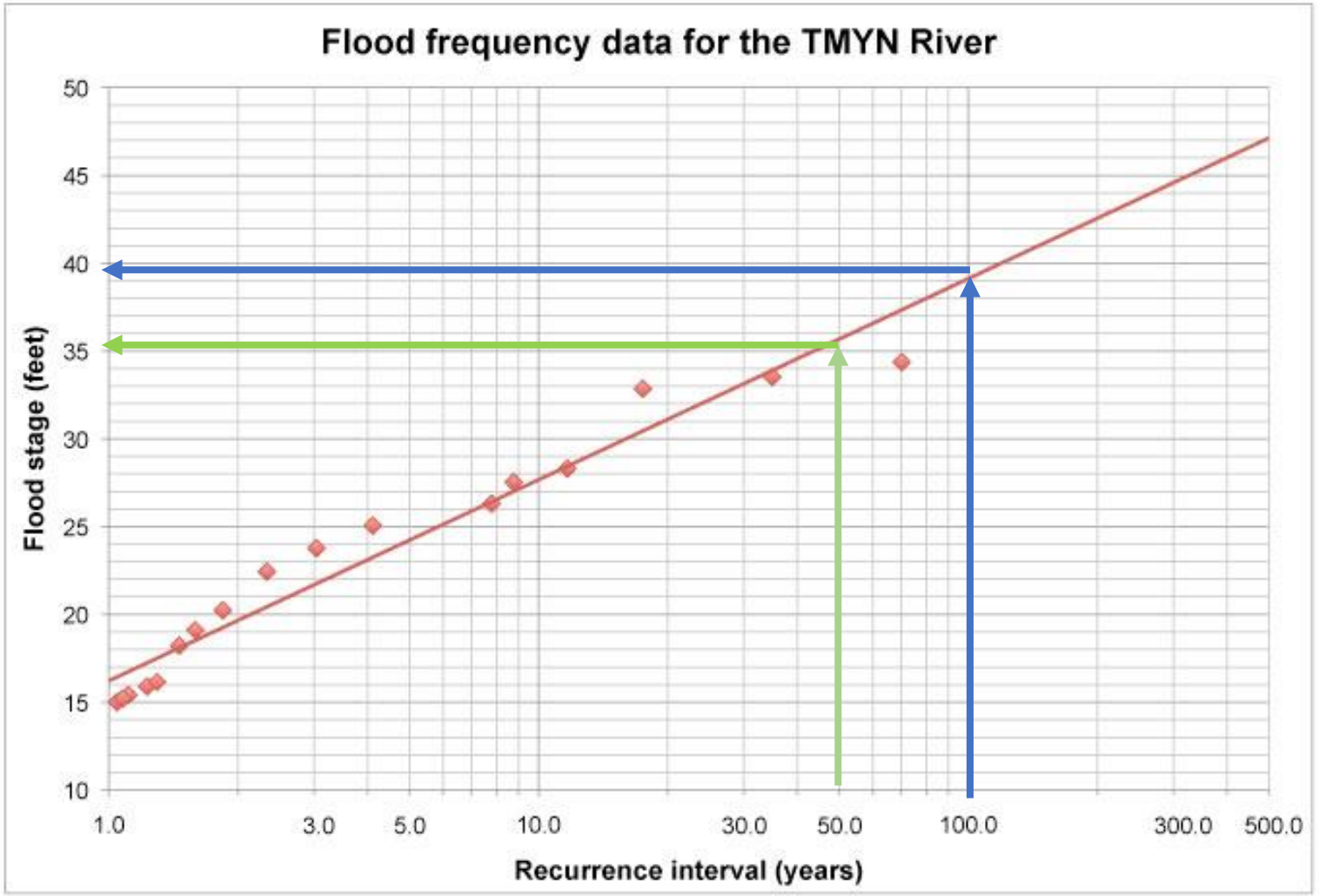
- The **100-year return period of floodplain** is the land that is predicted to **flood** during a **100-year** rainfall, which has 1% chance of occurring in any given **year**
- A **return period**, also known as a **recurrence interval**, is an estimate of the likelihood of a flood event to occur

Return Period (year) = 1 / Annual Exceedance Probability (%)

Annual Exceedance Probability (%) = 1 / Return Period (year)

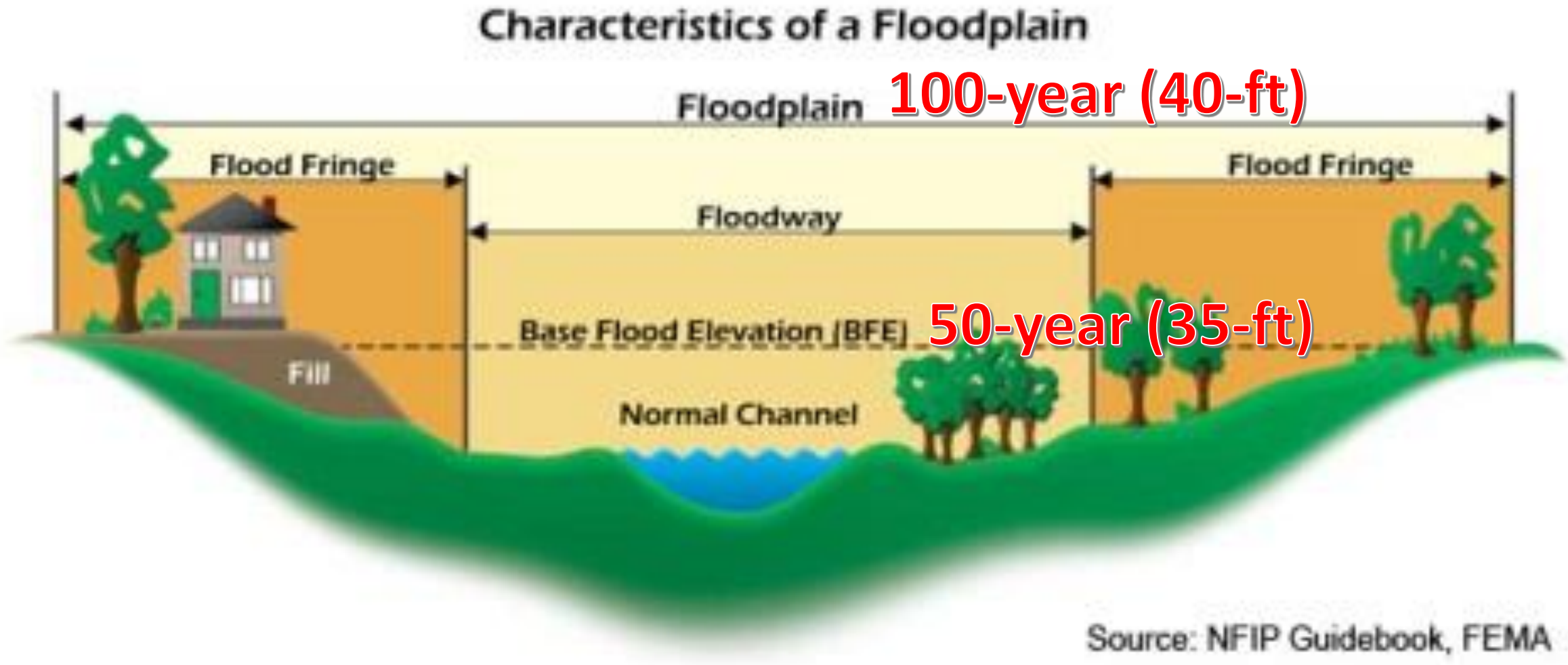
- The 100-year is used since this is the adopted standard design protection level for flood prevention

Recurrence intervals and probabilities of occurrences		
Recurrence interval (years)	Probability of occurrence in any given year	Chance of occurrence in any given year (%)
100	1 in 100	1
50	1 in 50	2
25	1 in 25	4
10	1 in 10	10
5	1 in 5	20
2	1 in 2	50



Over recent decades, possibly due to **global climate change**, 100-year floods have been occurring worldwide with frightening regularity (i.e. the 40-ft flood stage would be seen more frequent – instead of once in 100-yr, now could be in 10-yr [increased 10 times])

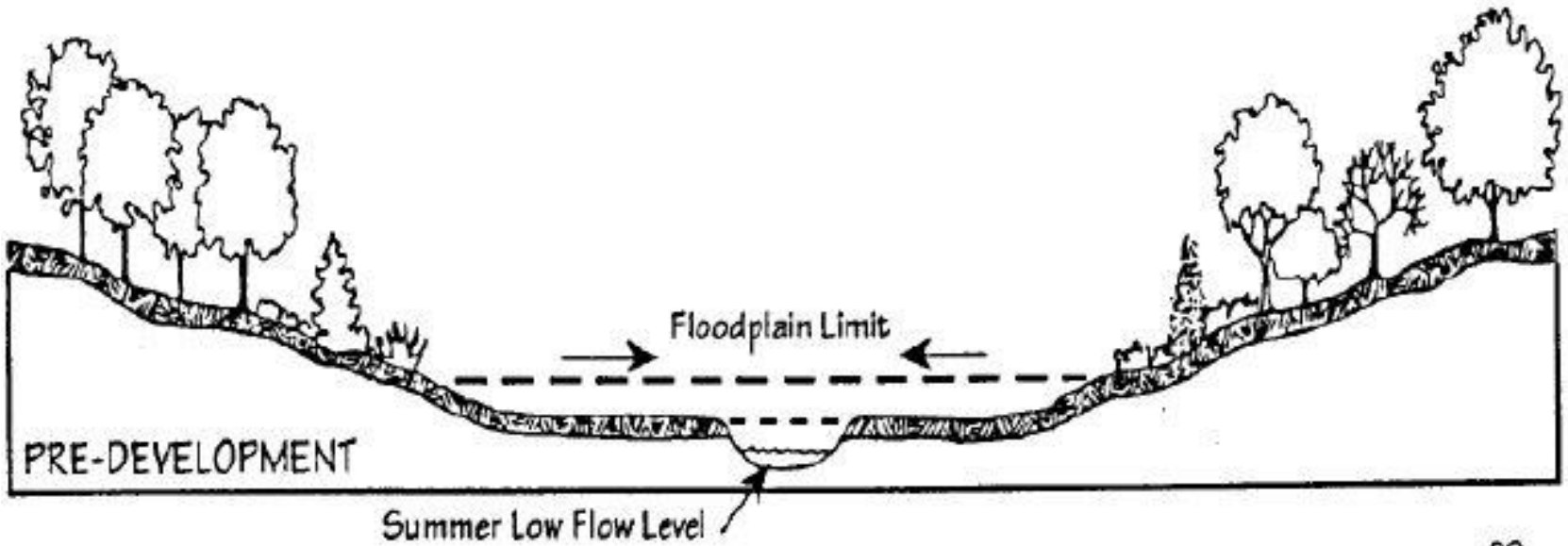
Impact of using wrong Return Period



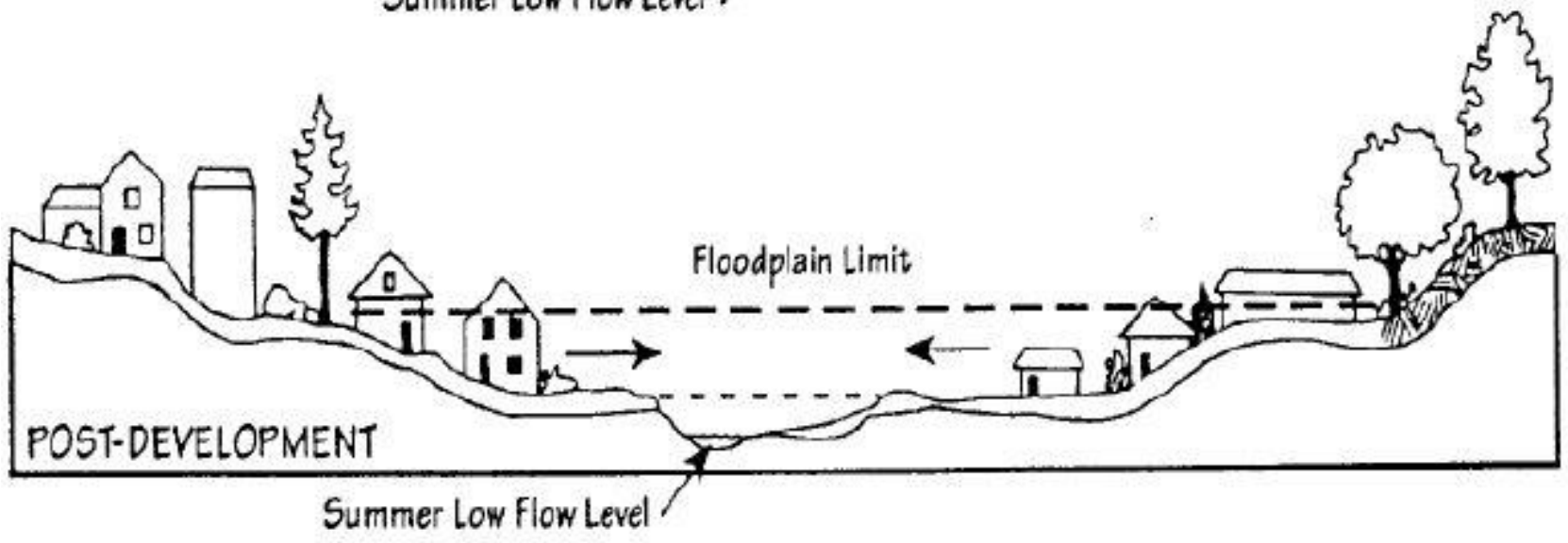
http://www.ci.watertown.wi.us/departments/floodplain_information.php#.W5OD--gzbIU

Floodplain : Before and After Developments (both are 100-year)

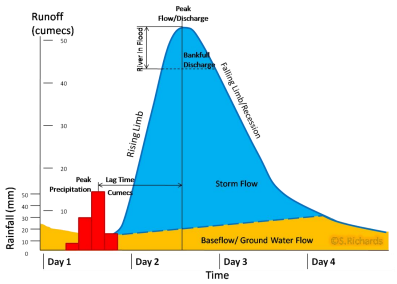
100-Year
Pre Development
Floodplain



100-Year
Post Development
Floodplain



Runoff Hydrograph



Qpeak
(higher)

Post-development
More runoff volume
Arrives faster

(20% to 30%)

We don't want this !

Runoff (cfs)

Flood Volume = Area under the hydrograph

Time-lag

Pre-development (< 10%)

We want this !

tc
(smaller)

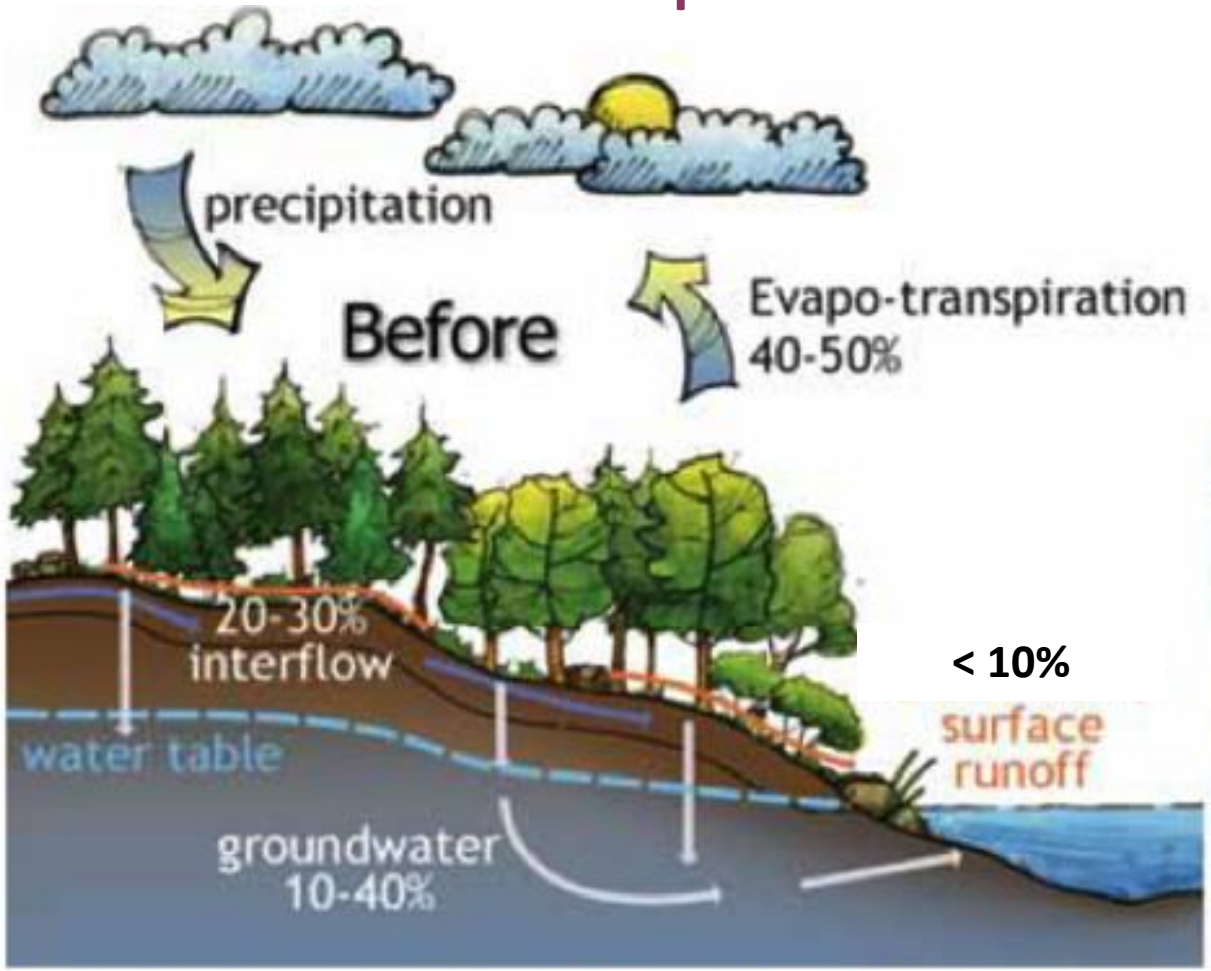
Time (hrs)

Horsley Witten Group, Inc.

https://www.slideshare.net/savebuzzardsbay/thinking-about-clean-water-and-development

https://auma.ca/advocacy-services/programs-initiatives/water-management/watershed-management/stormwater

Pre Development



Post Development

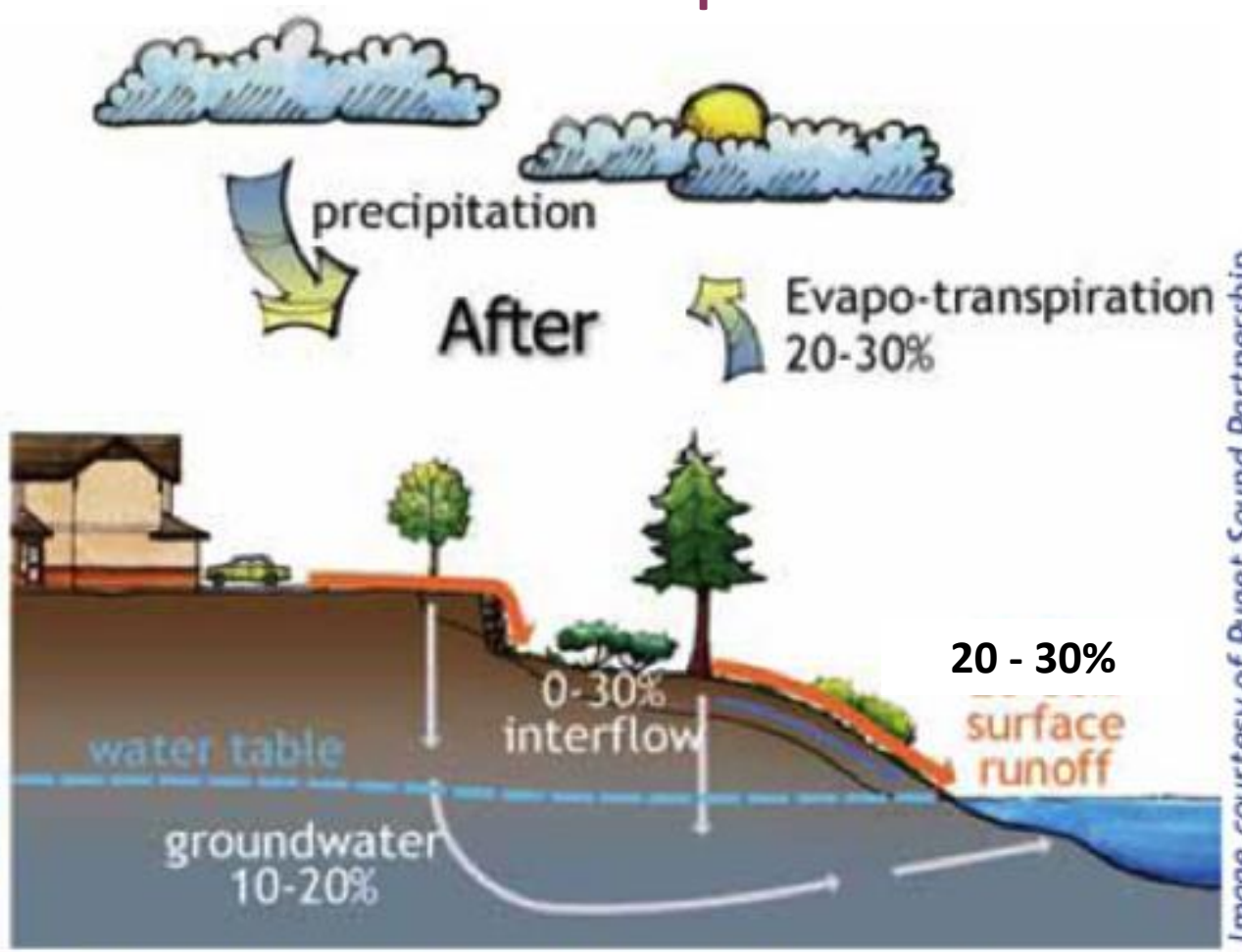


Image courtesy of Puget Sound Partnership

Before *development almost all rainfall is taken up by plants, evaporates or infiltrates through the ground.*
After *conventional development, surface runoff increases significantly while evaporation and infiltration into the ground decrease.*

Flood Mitigation - Structural Measures :

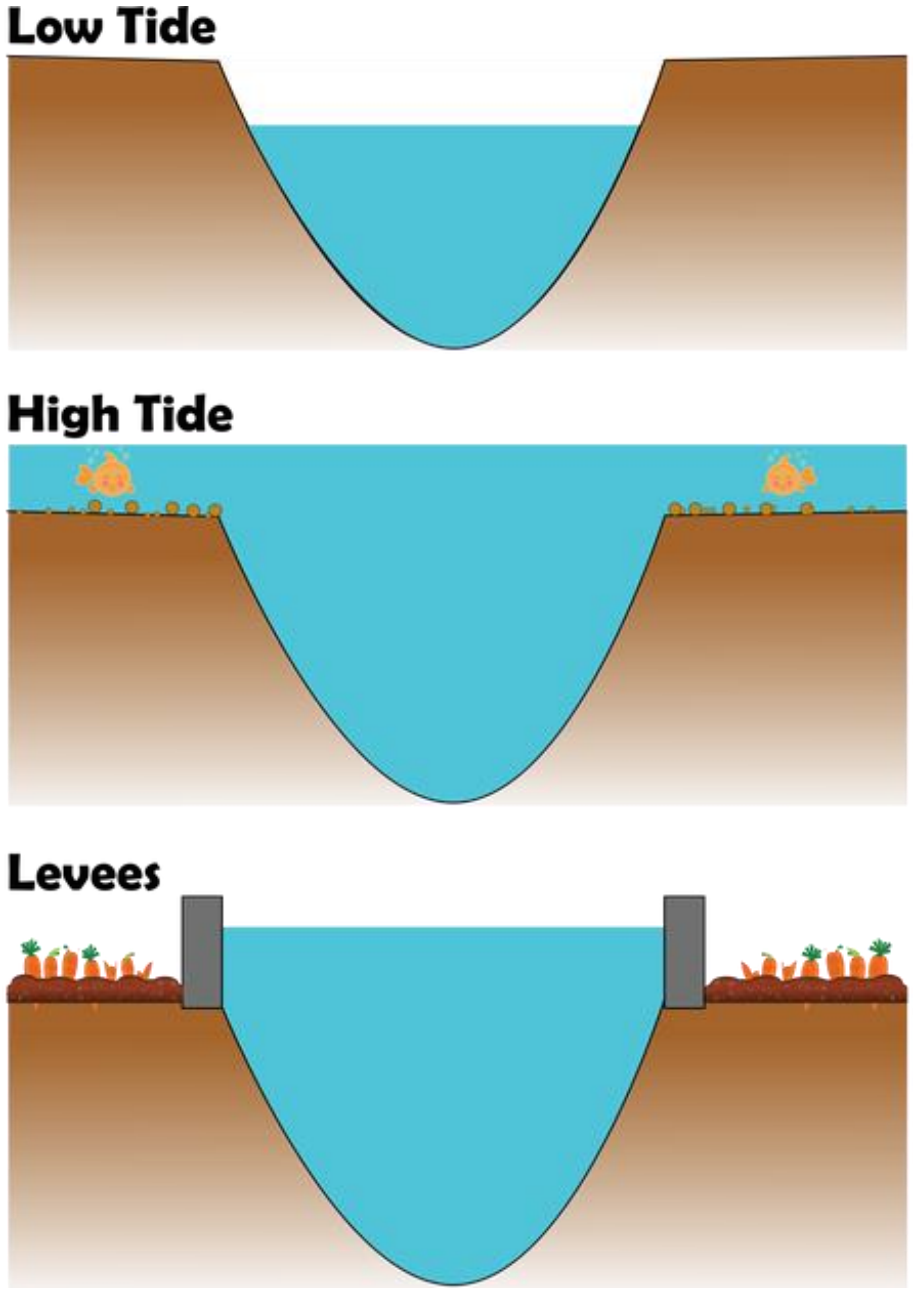
- Structural flood mitigation (100-year return period design) is where physical structures are constructed to reduce the impact of flooding;
  - Conventional methods: levees, additional channels, etc.
  - Green technologies: retention/detention pond, swales, green roofs, rain gardens, permeable paving, etc.

Levees

https://utazom.com/utazas/del-kinai-nagykorut-jangce-hajouttal-0

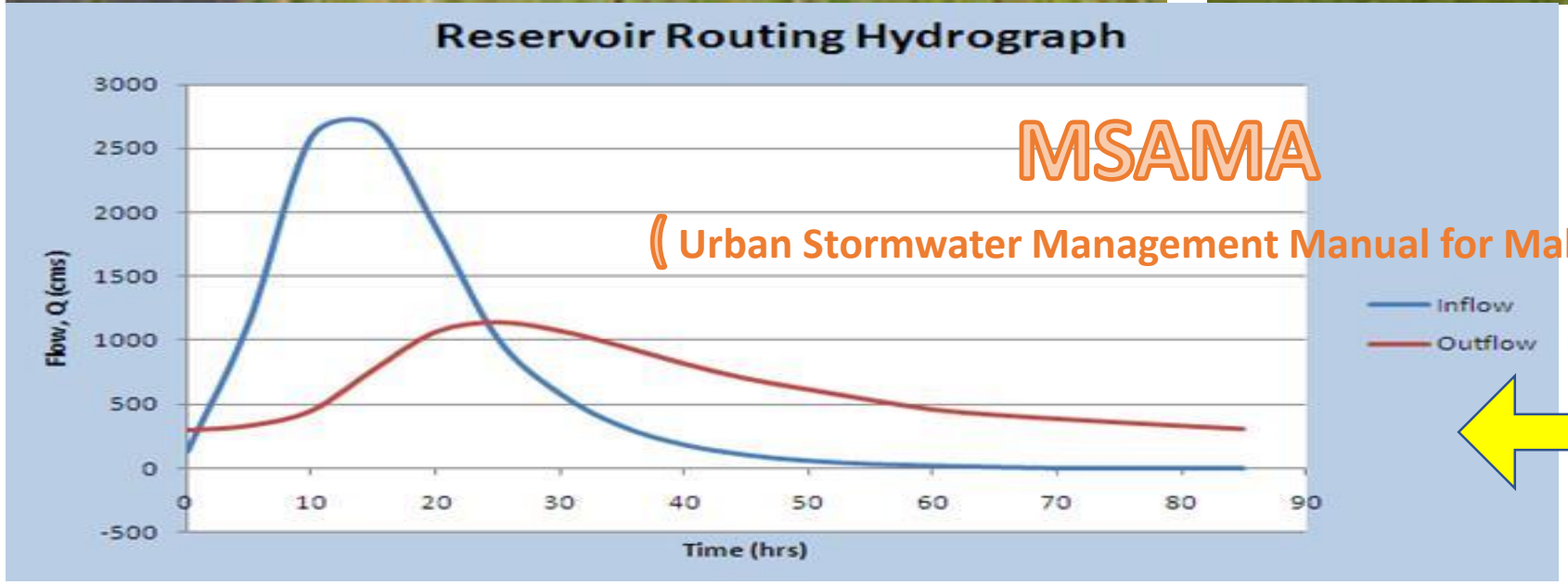
http://www.waterdamageout.com/water_damage_sacramento_next.htm

Levees



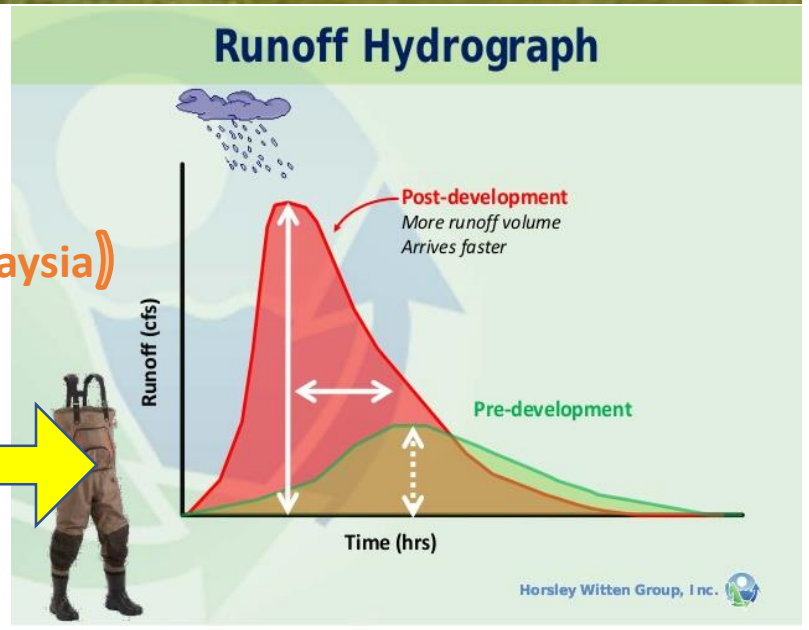
https://robinmclachlan.com/2016/10/29/the-levee-dilemma/

Detention & Retention Pond

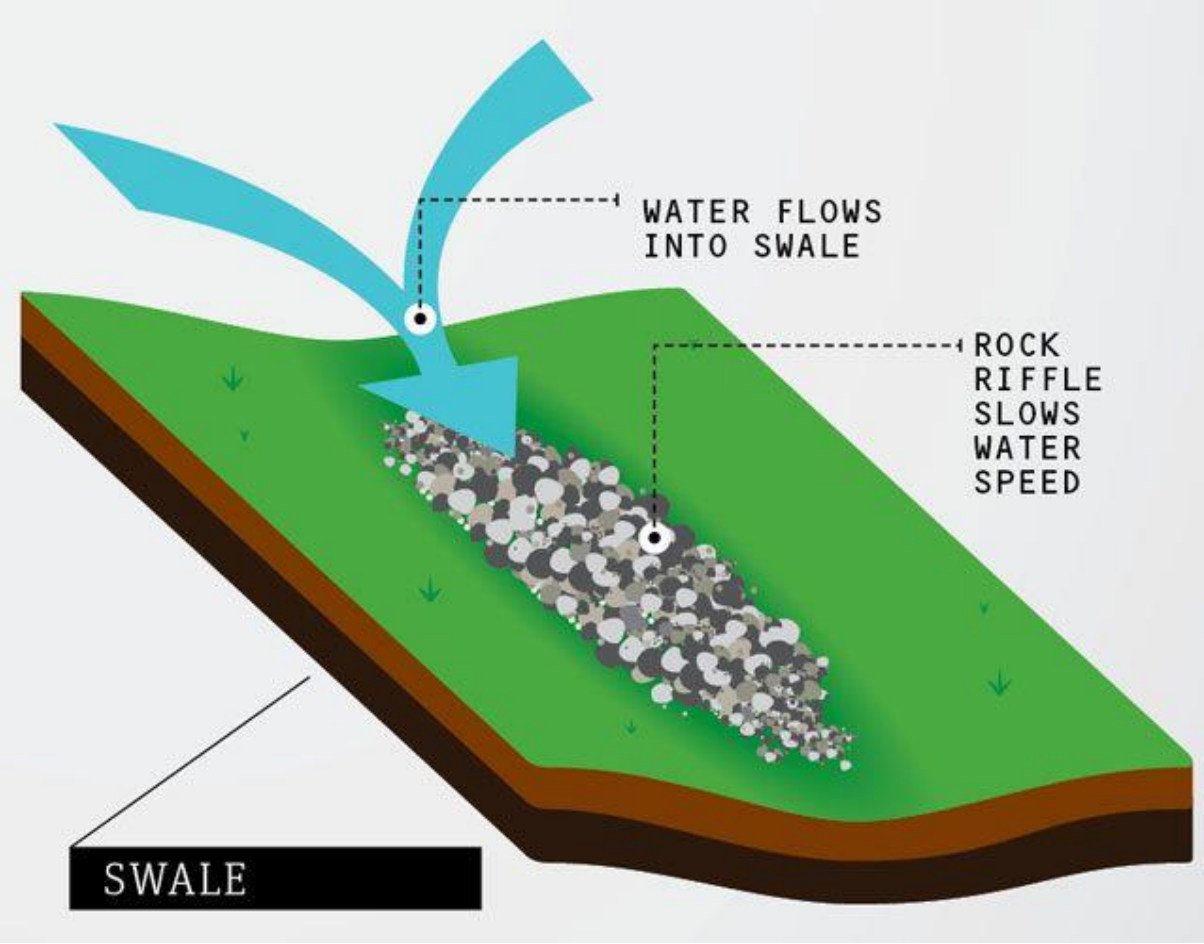


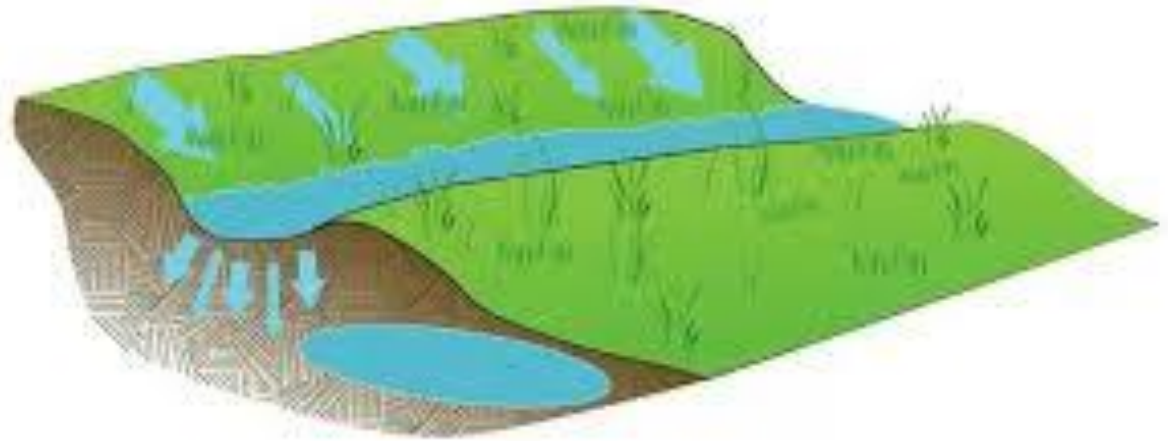
MSAMA

(Urban Stormwater Management Manual for Malaysia)



Swales

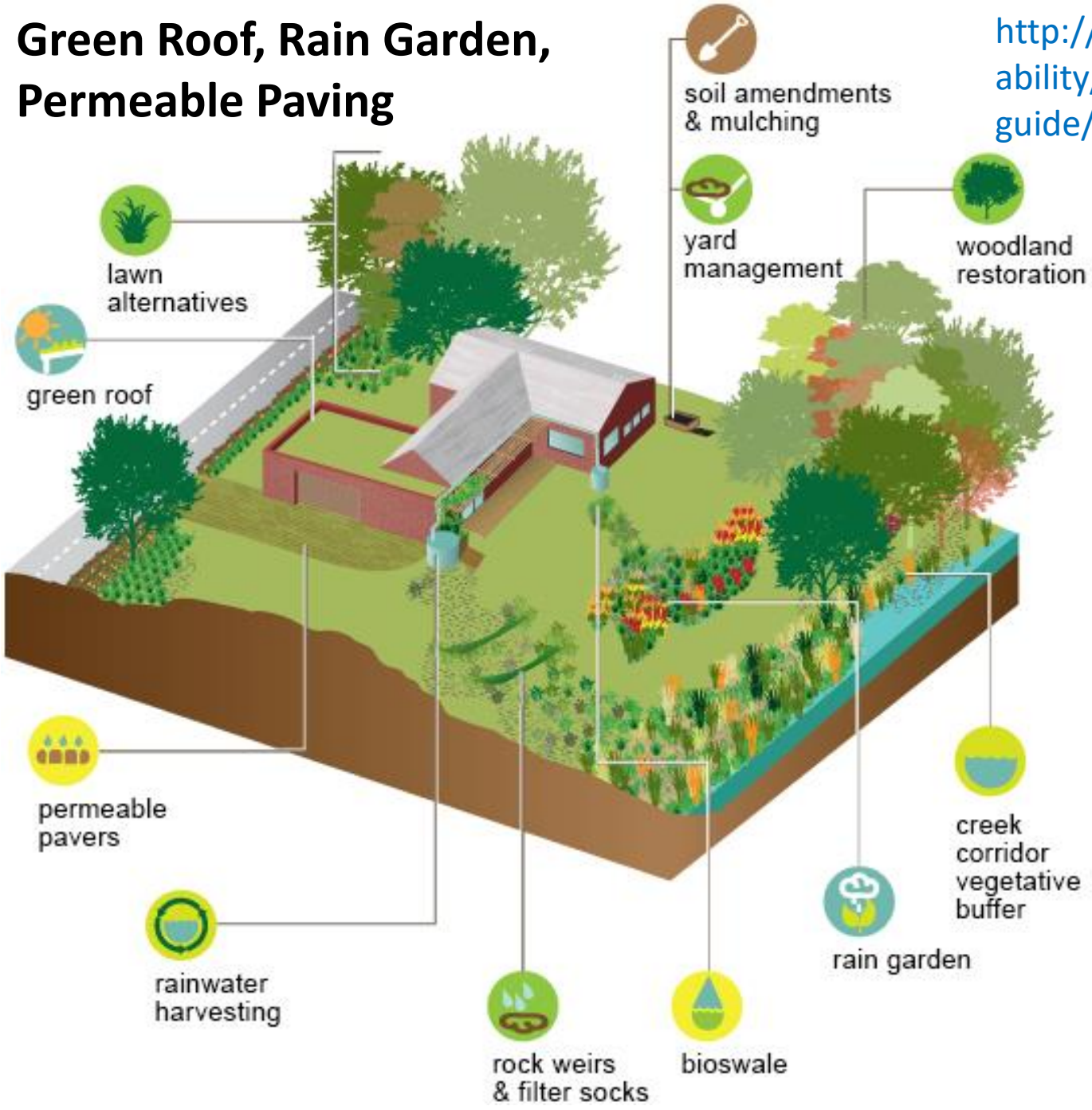




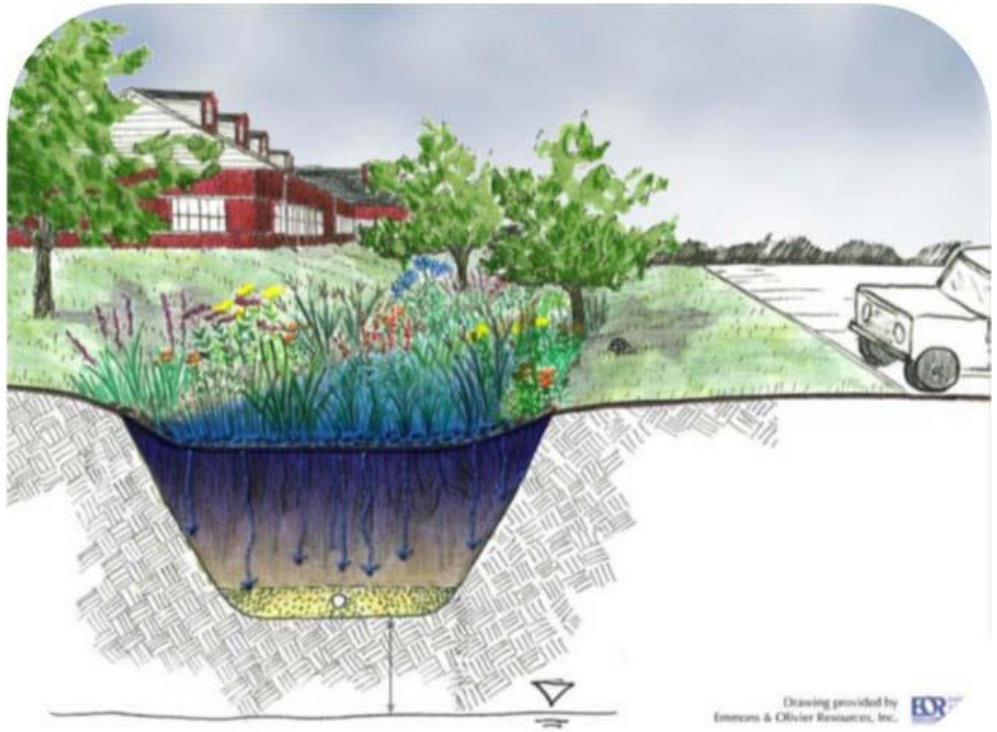
http://kstonehouse.itag.pw/flat-roof-water-pooling-solution

http://earthrepaircorps.org/2013/10/14/how-to-build-a-swale/

Green Roof, Rain Garden, Permeable Paving



http://www.missouribotanicalgarden.org/sustainability/sustainability/sustainable-living/at-home/rainscaping-guide/permeable-pavement.aspx



https://lrienergysolutions.com/services/water-efficiency/storm-water-management/

YouTube (6 minutes):

What is Floodplains by Design?

https://www.youtube.com/watch?v=-PBT4OEJfGs

Flood Mitigation - Non Structural Measures :

Land use planning controls

- Strategic land use planning will identify the extent of flood impacted land to limit the construction of urban and rural residential, commercial and industrial land.

Early warning systems

- Early warning systems are extremely important in **flash flooding** events to provide residents with the ability to respond to impending flood waters.

River Basin flood modelling

- Maintaining up-to-date flood models of developing river basins (land use change);
- To assist the stakeholders to understand the impact of new development on existing residents in the river basins

Flood Risk Map (Non-structural flood mitigation measure)

- The most effective way of reducing the risk to people and property is through the production of flood risk maps;
- Most countries have produced maps, which show areas prone to flooding based on historical flood and rainfall data;
- Again, the **100-year of return period** is used since this is the adopted standard design protection level for flood prevention;
- The most sustainable way of reducing risk is to prevent further development in flood prone areas. It is important for those **at-risk communities** to develop a comprehensive **Floodplain Management Plan** based on the flood risk maps

Canada-Newfoundland Flood Damage Reduction Program

FLOOD INFORMATION MAP

BADGER

FLOODING IN BADGER

This map is a Public Information Document and is to be used for general reference only. The information is based on the Flood Risk maps for Badger.

Copies of this map and information on the Flood Damage Reduction Program may be obtained from:

Flood Damage Reduction Program
Department of Environment
Government of Newfoundland and Labrador
P.O. Box 4750
St. John's, Newfoundland
A1C 5T7

Flood Damage Reduction Program
Inland Waters Directorate
Environment Canada
4th Floor, Queen Square
45 Alderney Drive
Dartmouth, Nova Scotia
B2Y 2N6

The designated Flood Risk maps are suitable for use by elected officials, land use planners, developers, builders and prospective seeking home or business locations. They may be viewed at the Town Council Office in Badger, the Department of Environment Offices in Corner Brook, Grand Falls, and St. John's.

Copies of the Flood Risk maps may be ordered for a nominal fee from:

Department of Forest Resources & Lands
Mapping Division
Howley Building, Higgins Line
P.O. Box 4750
St. John's, Newfoundland
A1C 5T7

Designed by LUNDRIGAN-CROWLEY

The Town of Badger is located at the convergence of two small brooks and the Exploits River, upstream of Grand Falls.

Flooding at Badger is a result of the back-up of water caused by ice construction. There has been no damage reported due to flooding at Badger during ice-free seasons.

Flooding in the lower areas of the town adjacent to the Exploits River has caused damage to private homes and public facilities in the community.

Flooding events have been recorded in the Badger area since 1903. A flood at Badger in the winter of 1916 (approximate) approached the intersection of Church Street and School road, almost up to the CNR tracks.

January 17-24, 1977 saw the worst flooding in Badger since 1943. This was believed to be caused by blockage at Badger Rough Waters. Ice in Badger Brook touched the bottom of the railway bridge at 99.67 m elevation.

During the week of February 28 — March 3, 1983, flooding occurred once again in Badger, the result of an ice jam in Badger Rough Waters. Homes were evacuated and flood damage was reported to be $89,000, excluding costs for ice blasting operations.

FLOOD INFORMATION MAP

BADGER • NEWFOUNDLAND

SCALE

METRES 100 0 100 200 300 400 METRES

FEET 250 0 250 500 750 1000 1250 1500 FEET

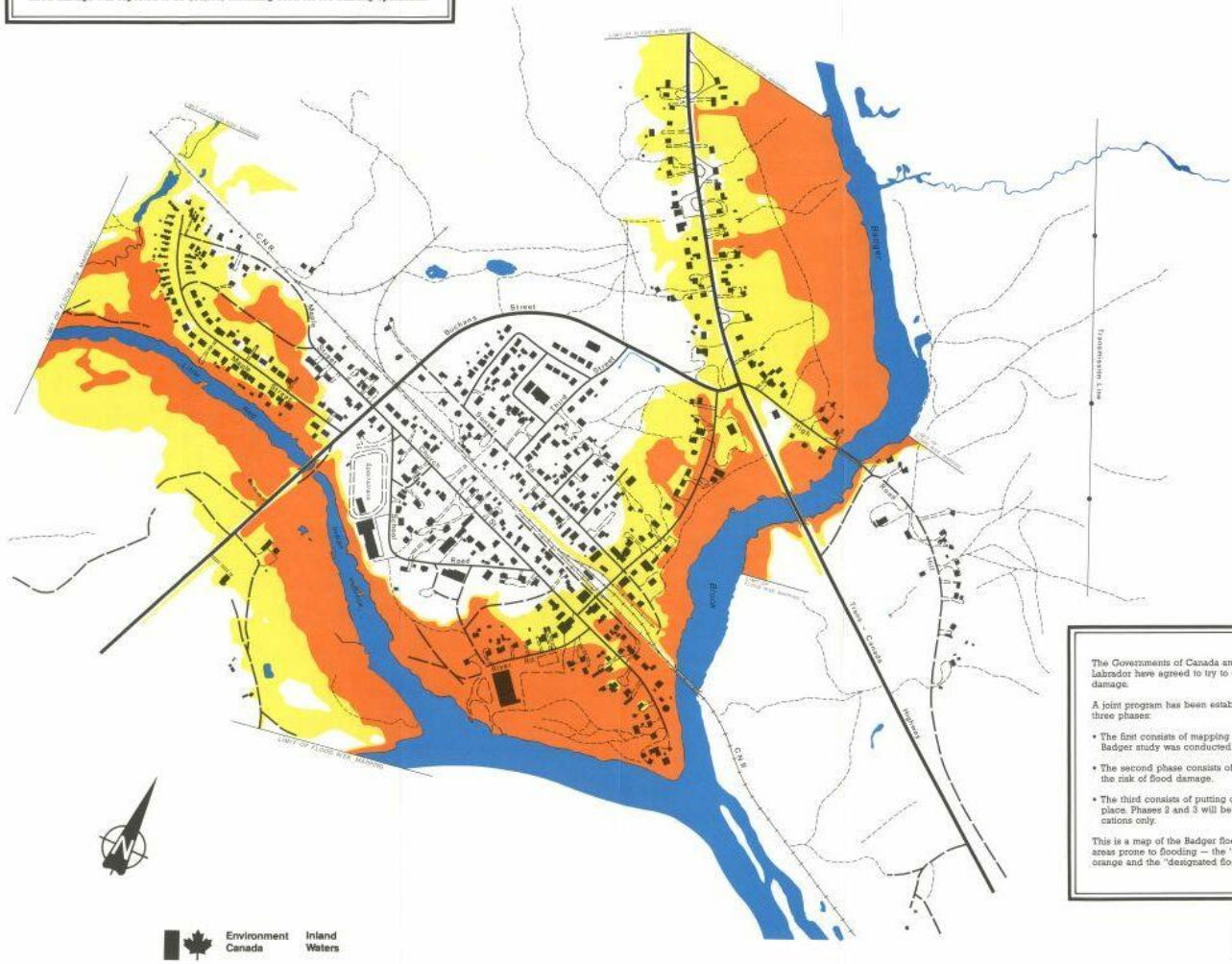
A "designated floodway" is the area subject to most frequent flooding.

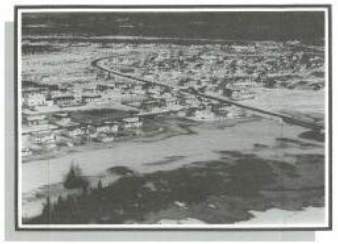
A "designated floodway fringe" constitutes the remainder of the flood risk area. This generally receives less damage from flooding.

No building should be erected in the "designated floodway" since extensive damage may result from deeper and more swiftly flowing waters. However it is often desirable and may be acceptable to use land in this area for agricultural and recreational purposes.

Within the "floodway fringe" a new building, or an alteration to an existing building should receive flood proofing measures. A variety of these may be used, e.g. the placing of a dyke around the building, the construction of a building on raised land, or by the special design of a building.

Buildings erected prior to the designation of these two areas may still be eligible for flood damage compensation.





The Governments of Canada and Newfoundland and Labrador have agreed to try to control and reduce flood damage.

A joint program has been established for implementation in three phases:

- The first consists of mapping the flood risk areas. The Badger study was conducted under this phase.
- The second phase consists of studying ways to minimize the risk of flood damage.
- The third consists of putting cost-effective solutions in place. Phases 2 and 3 will be carried out for selected locations only.

This is a map of the Badger flood risk areas — showing areas prone to flooding — the "designated floodway" in orange and the "designated floodway fringe" area in yellow.

LEGEND

- Normal Water Surface
- 1:20 Year flood zone
- 1:100 Year flood zone
- Road, all season
- cart track
- Railway
- Building
- Stream/River

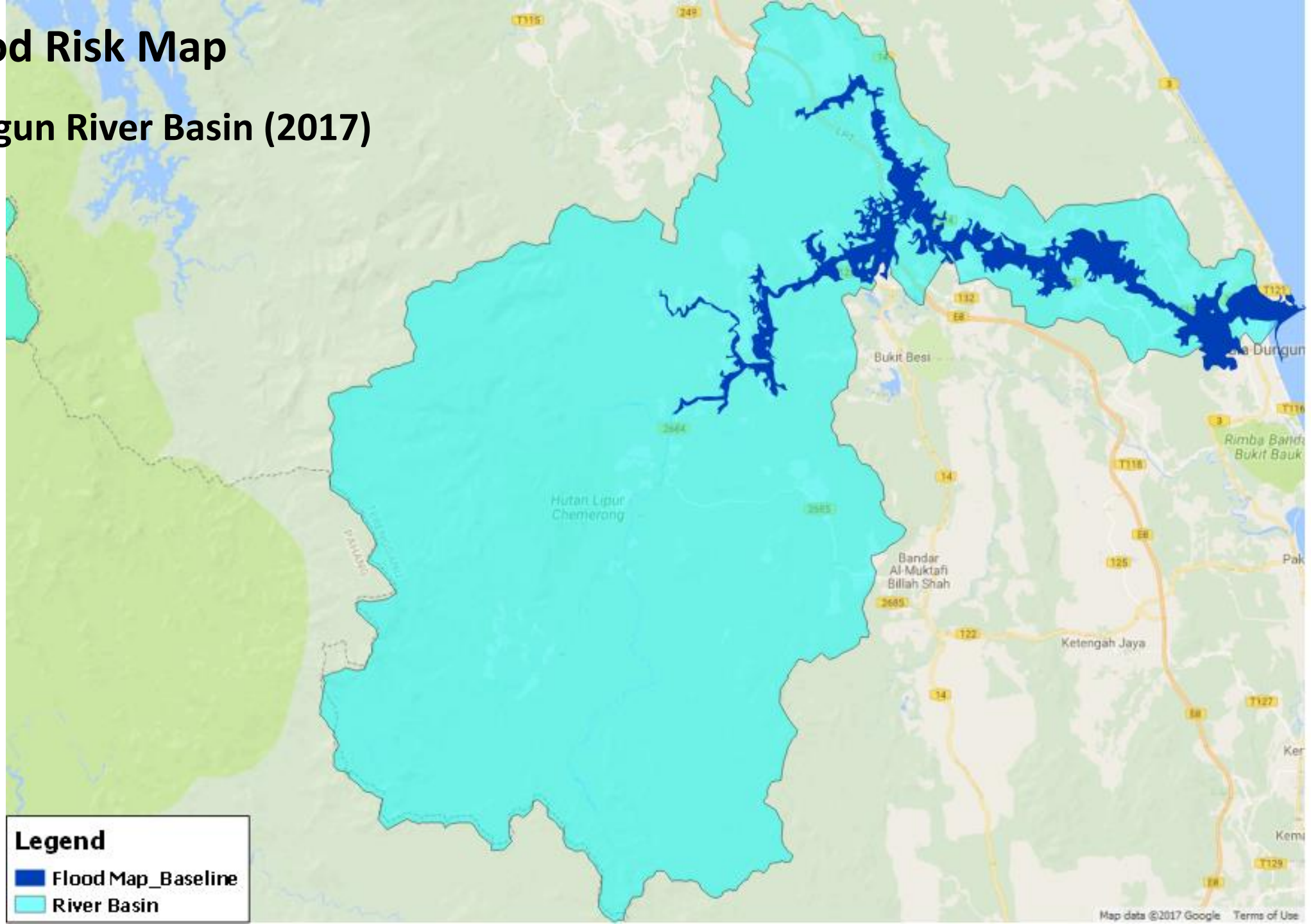
Environment Canada Inland Waters

Newfoundland Department of Environment
Water Resources Division

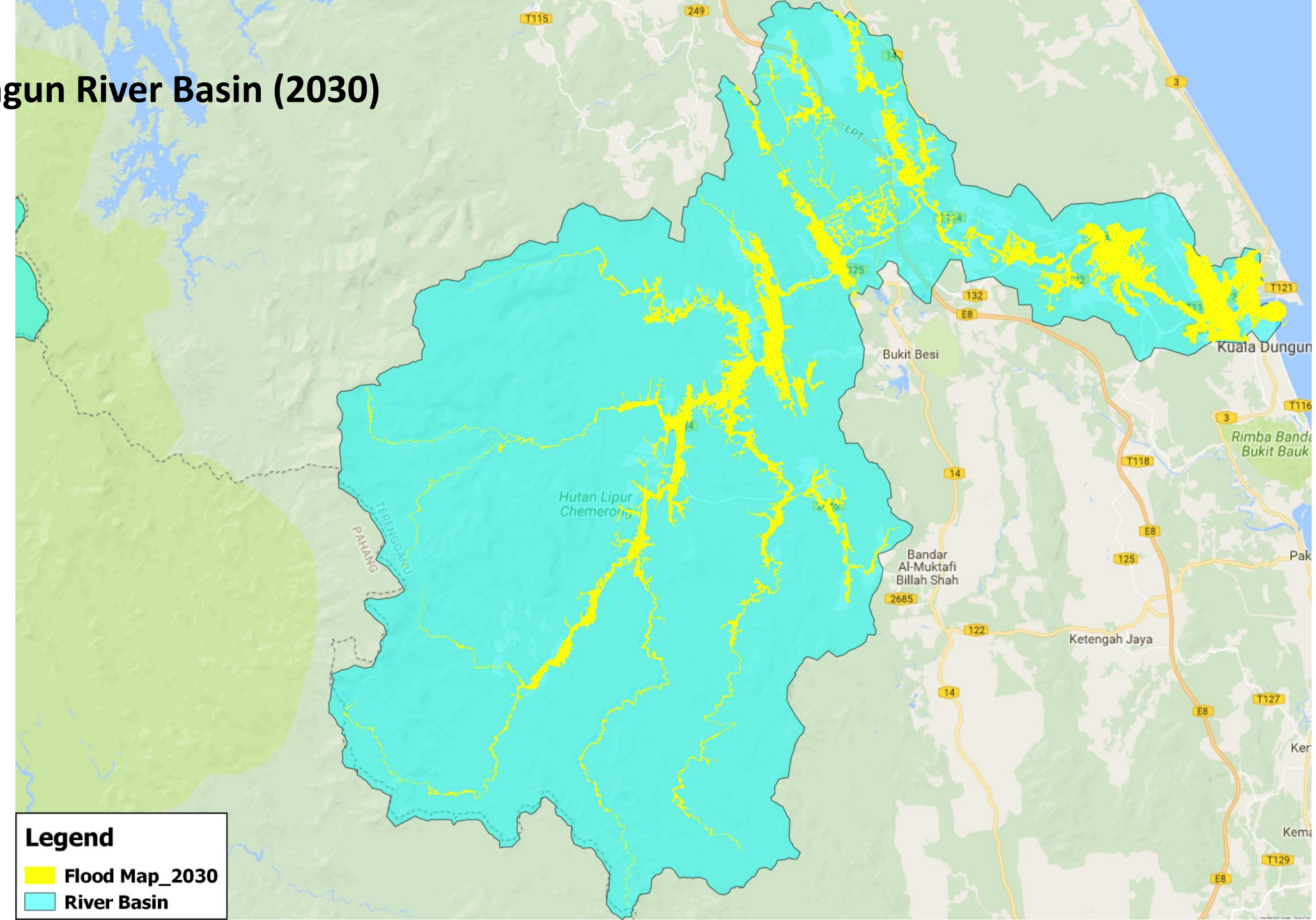
https://www.mae.gov.nl.ca/waterres/flooding/frm.html

Flood Risk Map

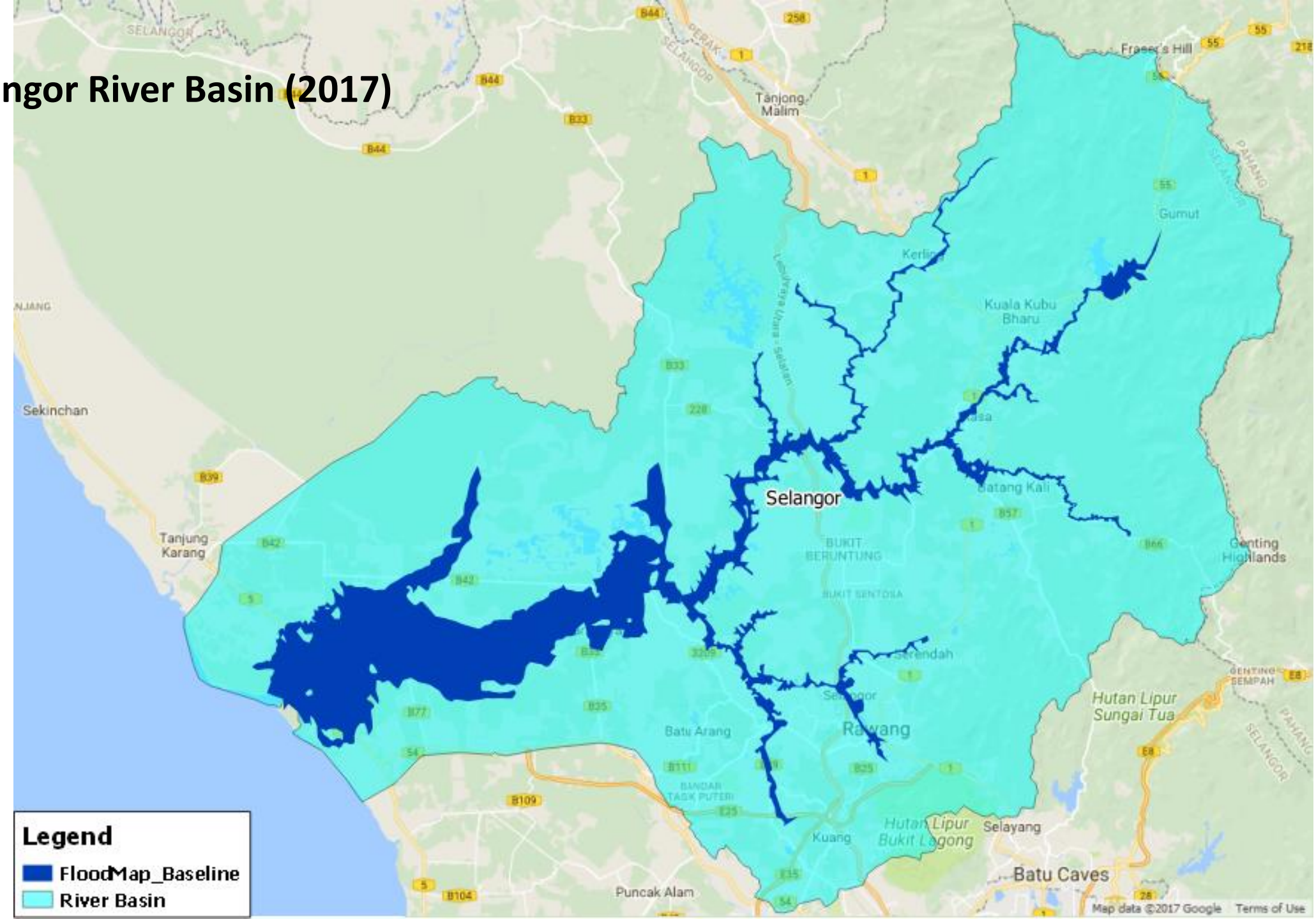
Dungun River Basin (2017)



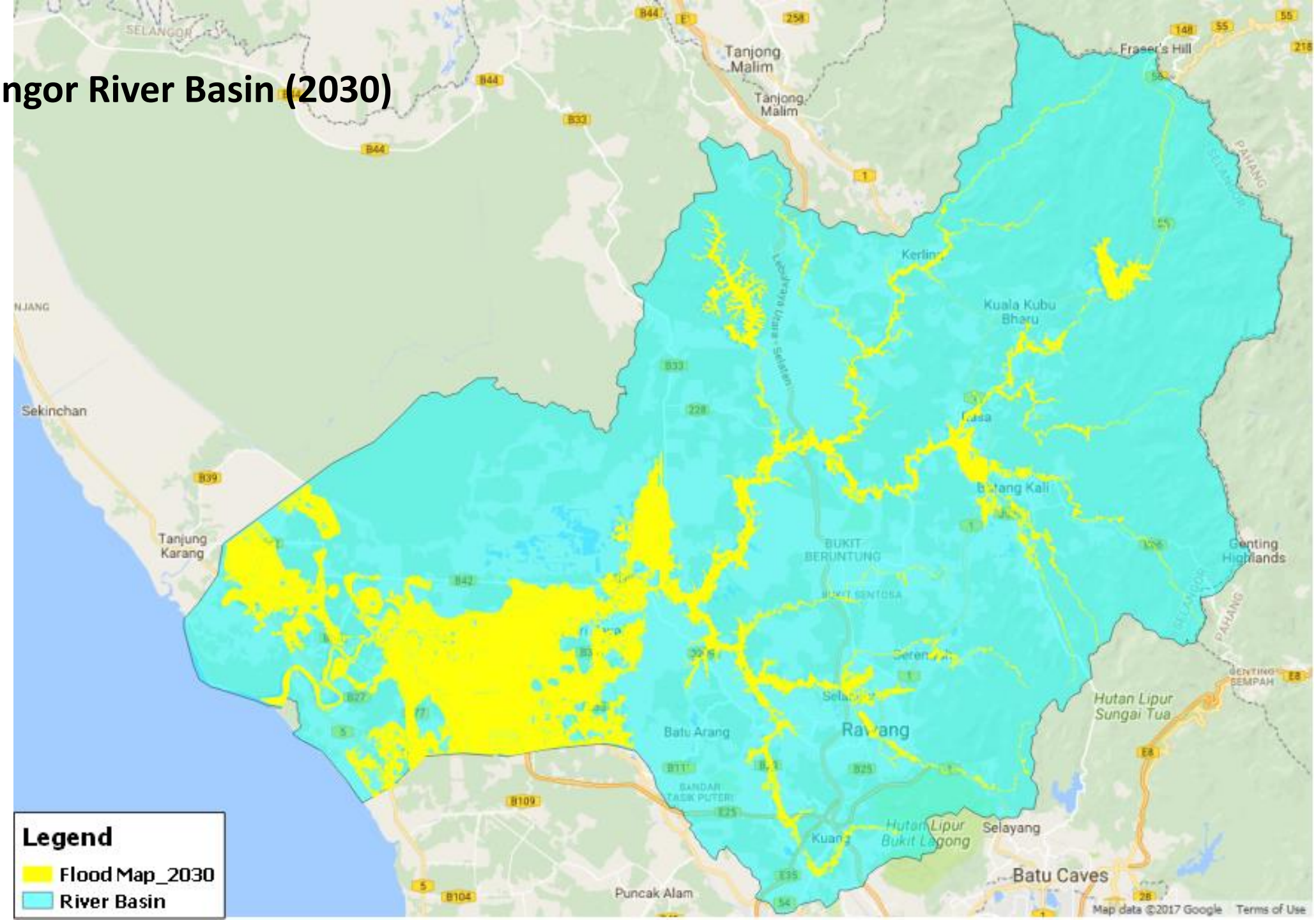
Dungun River Basin (2030)



Selangor River Basin (2017)



Selangor River Basin (2030)



YouTube (3 minutes):

Flood Mapping Basics

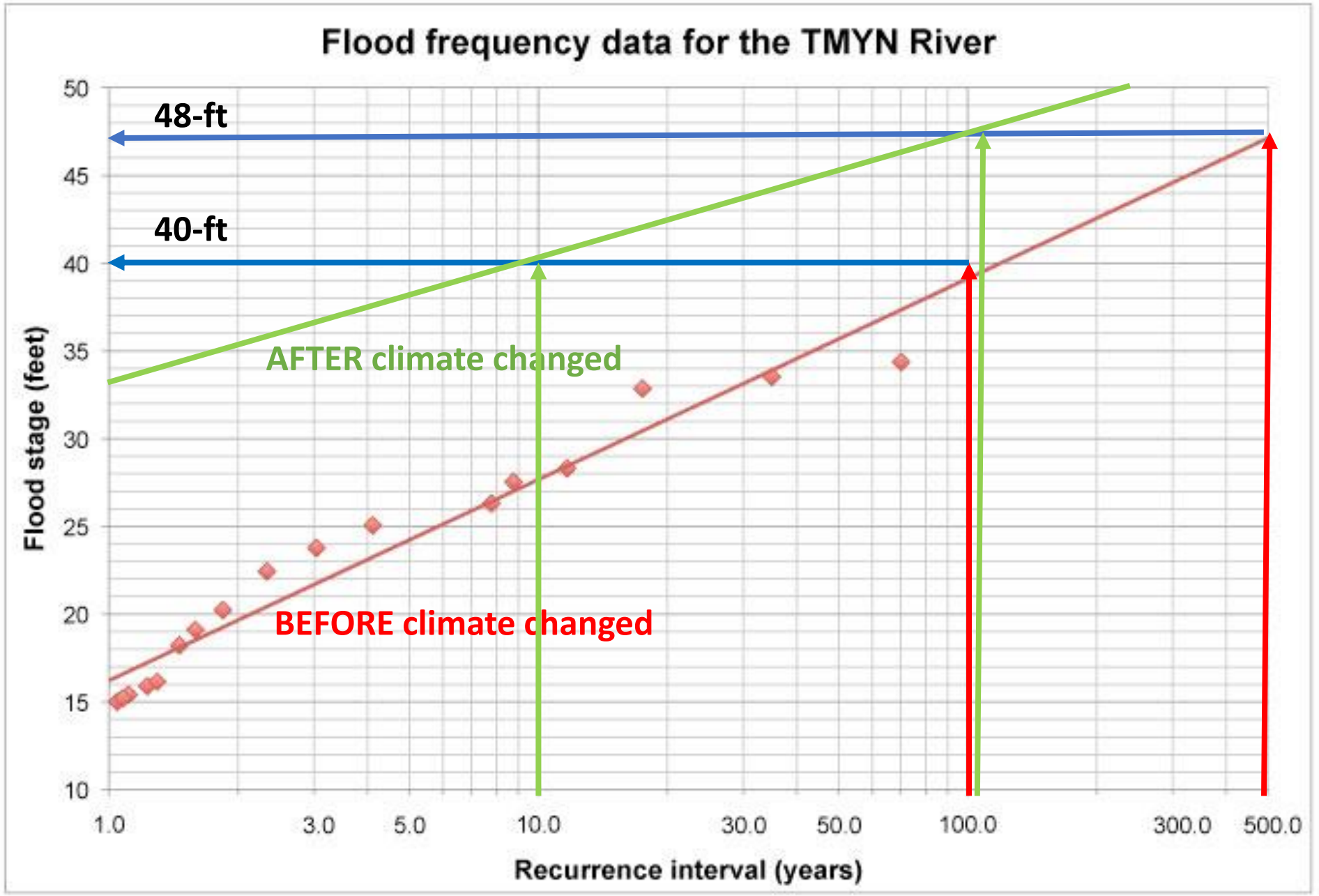
https://www.youtube.com/watch?reload=9&v=bNasdKVeivk

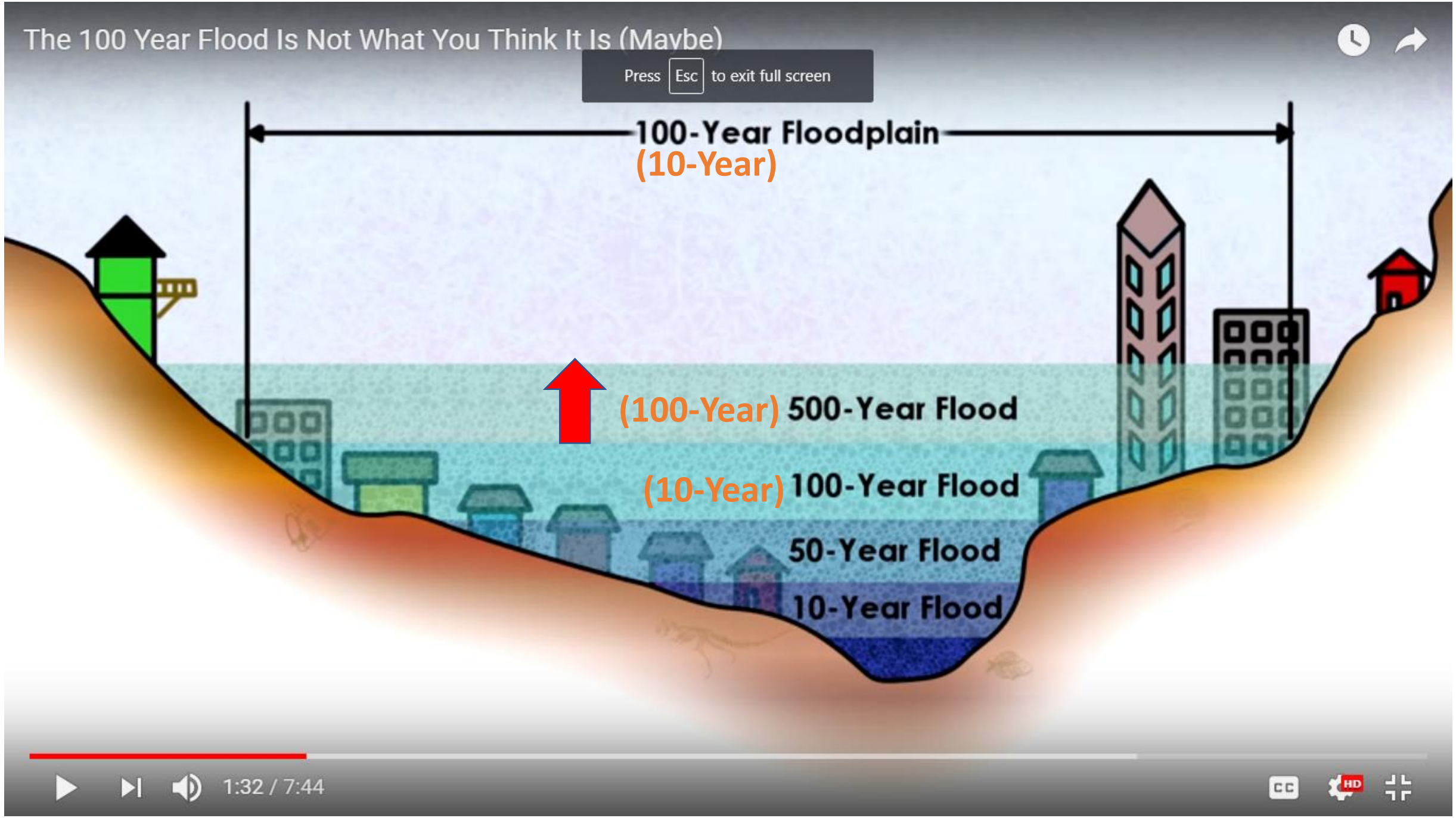
Impact of Climate Change

- The 100-year flood is no longer the 100-year flood; it may become 10-year flood now;
- While the 500-year flood is no longer the 500-year flood; it may become 100-year flood now;
- Possible? Why?

The Answer : YES
(Assumed higher rainfall after climate changed):

- Before climate changed, the 100-year flood that was expected to occur once in 100 years (usually it was due to a very heavy rainfall as it occurred only once in 100 years), was normal;
- After climate changed, it may occur more frequent (become abnormal), let's say 10 years instead of 100 years. So now, the 100-year (1% of probability to occur) flood has become 10-year (10% of probability to occur) flood;
- But do not forget, they have the same level of flood (40-ft). Just different frequencies (100 years vs 10 years) or probabilities (1% vs 10%);
- So what will be the new 100-year flood (after climate changed)? Much higher? Yes
- This is possible because the new 10-year flood is already equal to the old 100-year flood. Thus, the new 100-year flood now could be equivalent to the old 500-year (0.2% of probability to occur) flood (48-ft)


Flood frequency data for the TMYN River
48-ft
40-ft
AFTER climate changed
BEFORE climate changed
Flood stage (feet)
50
45
40
35
30
25
20
15
10
1.0
3.0
5.0
10.0
30.0
50.0
100.0
300.0
500.0
Recurrence interval (years)


The 100 Year Flood Is Not What You Think It Is (Maybe)
Press Esc to exit full screen
100-Year Floodplain
(10-Year)
(100-Year) 500-Year Flood
(10-Year) 100-Year Flood
50-Year Flood
10-Year Flood
1:32 / 7:44

Thank you