Floods, Droughts and Risks in IWRM

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Part 1

1. Extreme events: definitions
2. Flood and drought – as hazards
3. Basics of risk analysis

“Extreme Events”

tornados

floods

hurricanes

“Extreme Events”

landslides

droughts

mudflows

Flooding is a natural, weather induced event,
BUT - impacted by human interference in:

- hydraulic characteristics of river channels
- flow regimes
- altering watershed (land and vegetation) conditions

Anthropogenic factors - watershed changes:

- deforestation
- overgrazing (often related)
- draining wetlands
- urbanization

Influence: likelihood, frequency, magnitude and impact of floods

Mudflows: worsen the damage from floods alone

- main factor is hydraulic - high velocity and large mass
- more common in steep upper catchments
- made worse by deforestation, overgrazing, other land use changes, channel excavation, etc.

Definitions

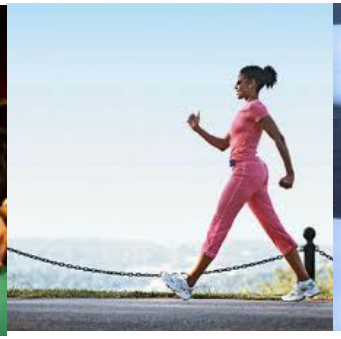
Three main terms used is considering floods, droughts and other extreme events:

1. ***Risk***
2. ***Hazard***
3. ***Vulnerability***

Definition of Risk

"Risk is the potential that a chosen action or activity will lead to a loss."







Definition of Risk

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Definition of Risk

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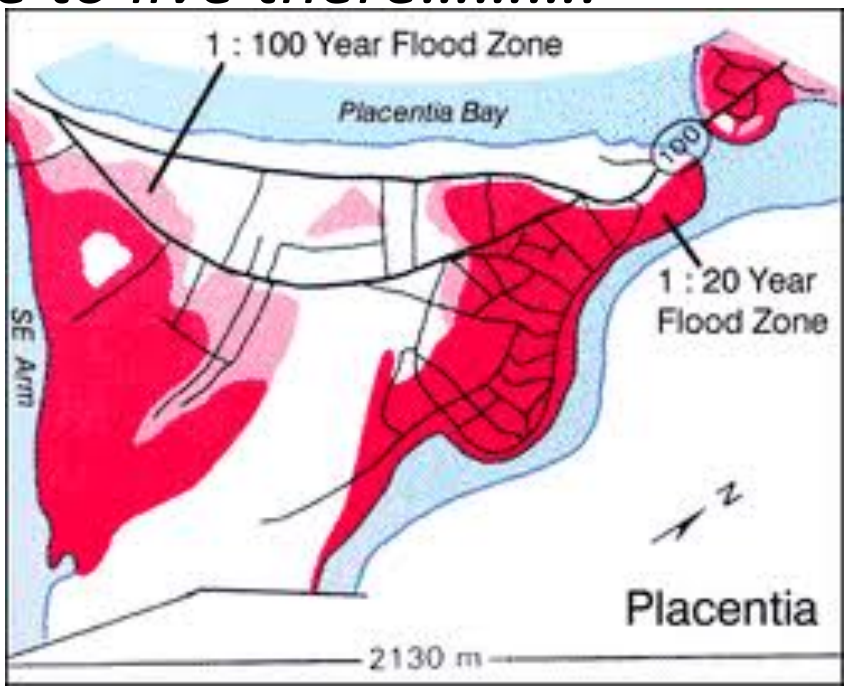
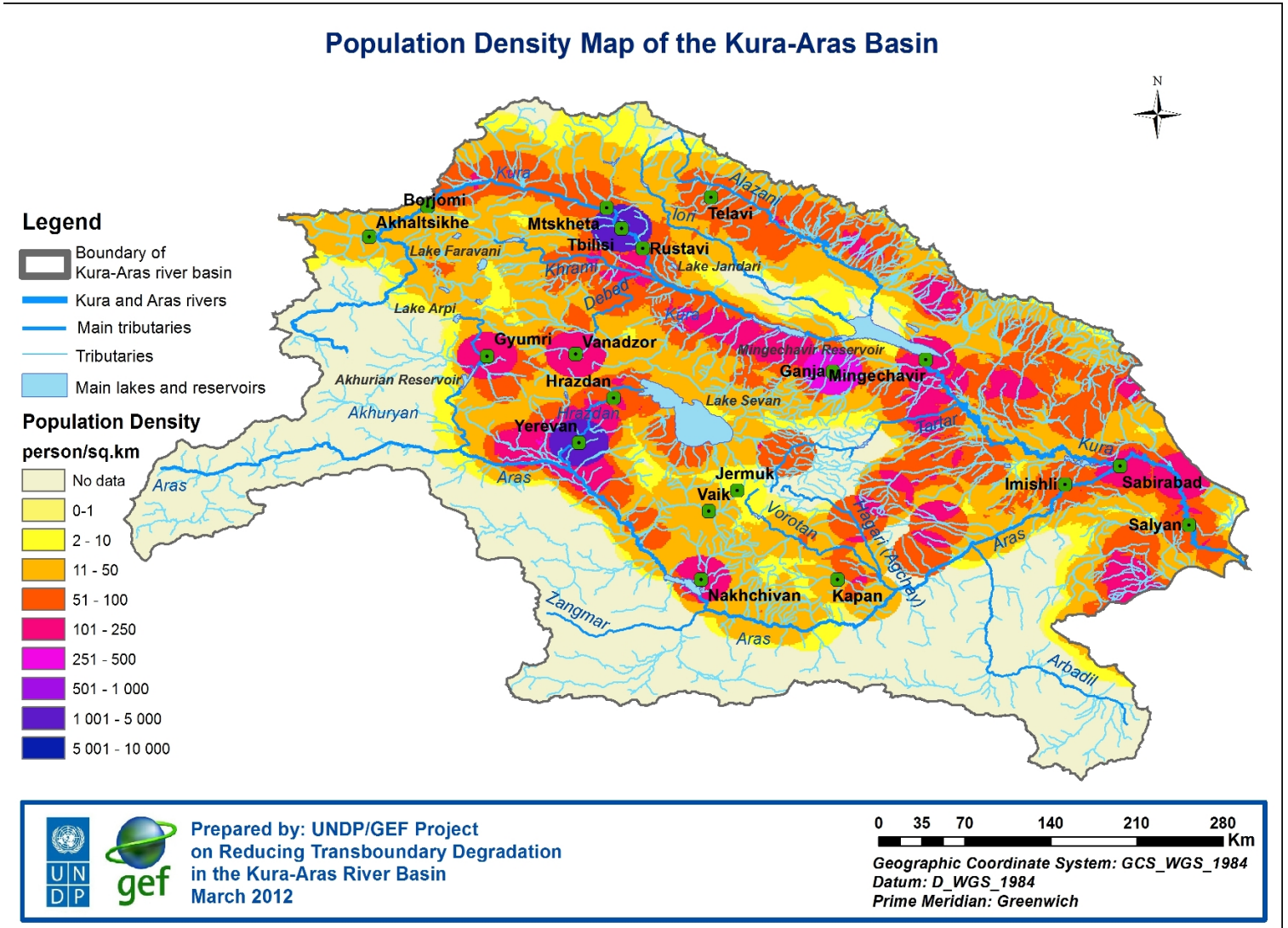
Definition of Hazard

Hazard is a measure of the potential for harm, or loss.

A flood plain is an area of hazard. It becomes a risk if you choose to live there…….



.....and people do choose to live there.



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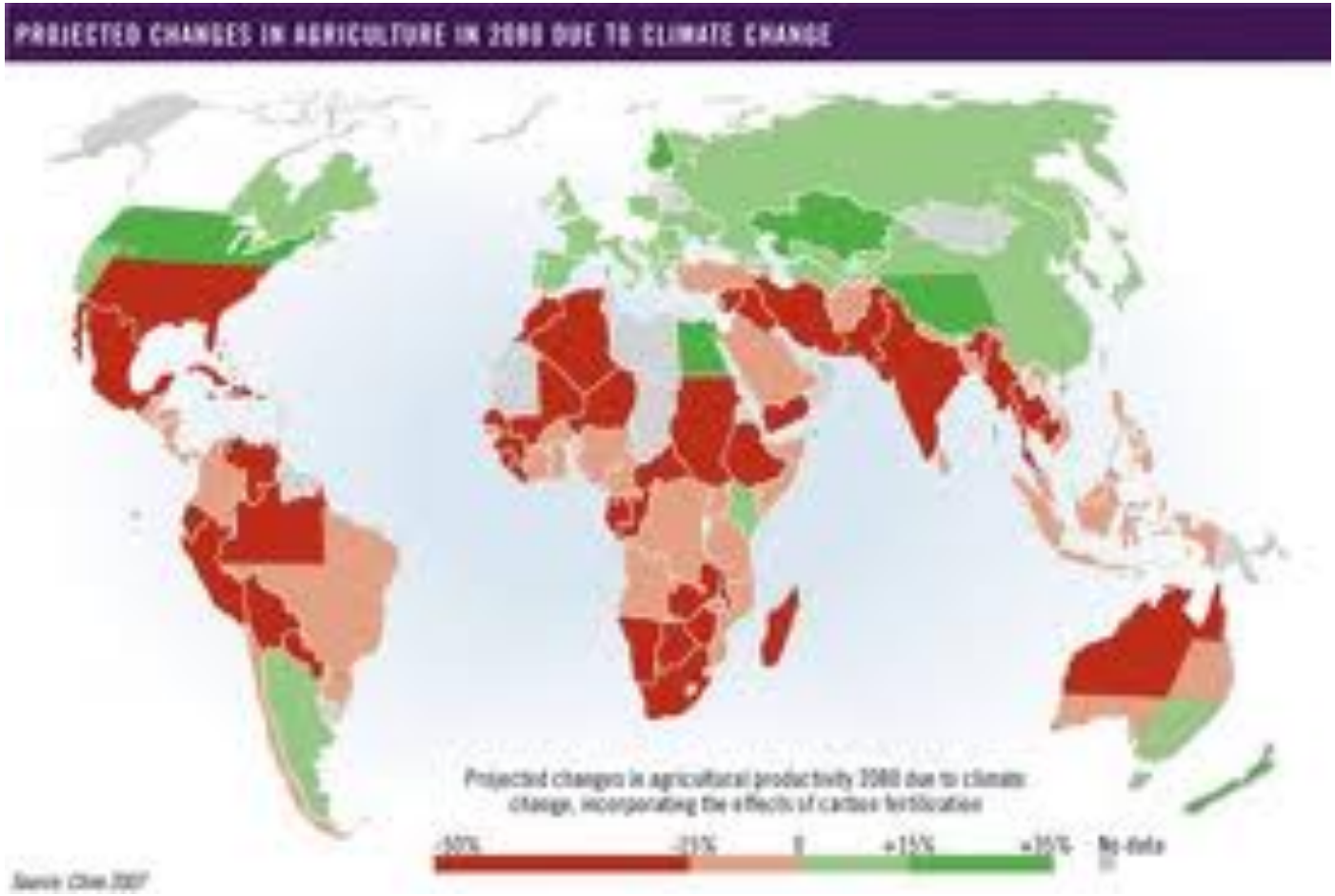


Why do people live near rivers on flood plains?

- access to water
- good waste disposal system
- level areas for agriculture
- trees (shade, wood)
- transportation, amenity
- flood risk accepted for these benefits
- *climate change now increasing flood risk*

Why do people live in drought prone areas?

- people live where they can grow food
- to some extent every area is drought prone
- some areas more risky than others
- area may not have been so bad when people first settled
- Land pressure moves people into higher risk areas
- *climate change now increasing drought risk*

Definition of Vulnerability

Vulnerability is a measure of person's or a society's ability to cope with a damaging event.

So:

a flood plain is an area of hazard. It becomes a risk if you choose to live there. You are vulnerable to the flood risk if the hazard is high and your ability to cope is low.

Definition of Vulnerability

Poor people tend to be more vulnerable to the impacts of flood or drought because they lack the ability to rebound from the event.

- Social vulnerability – loss of life, damage to person, health impacts, reduction of social services
- Economic vulnerability - loss of property, loss of income

Risk Analysis

Risk is about the probability of uncertain future events

Risk analysis is a mathematical approach to understanding the risk of exposure to hazard:

Risk = p(event occurring) X (cost if the event occurs)

= Expected Damage

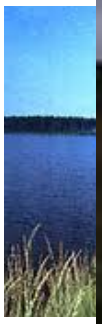
Analyzing Risk

Three components:

1. *flood magnitude* – how big is it?
2. *flood frequency* – how often does a flood that big happen?
3. *flood damage* – what is the amount of damage when that flood happens?

Measuring Flood Magnitude

River Flow Data – Water Levels



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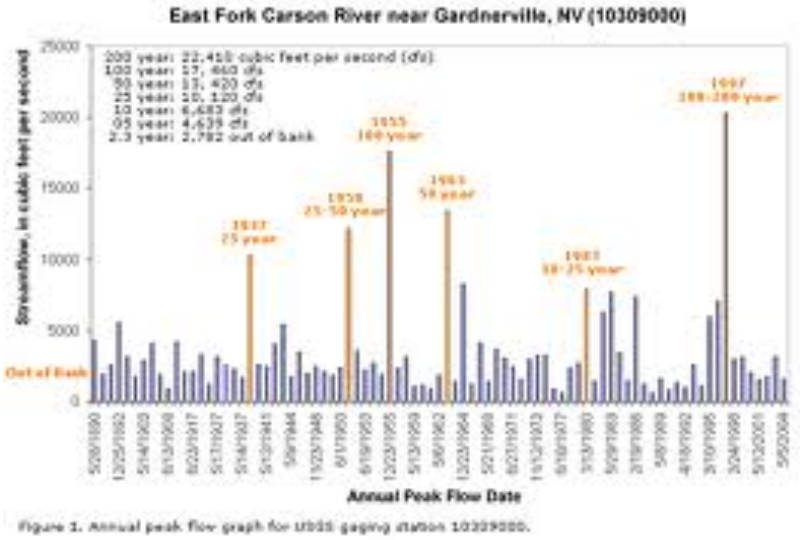
Other Sources of Information for Determining Flood Risk

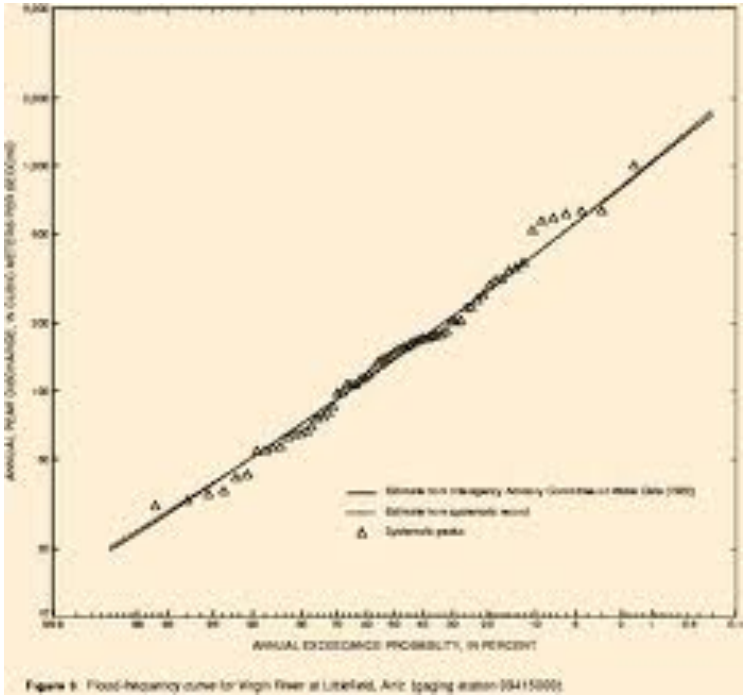
Magnitude Information – hydrological

- Stream gauging records
- Rainfall records
- Historic information (high water marks – local knowledge)
- Marking of flood levels after an event
- Newspaper accounts, diaries
- Physical and geomorphic evidence (erosion, boulders, debris
- Regional information (evidence from similar rivers in the area

Measuring Flood Frequency

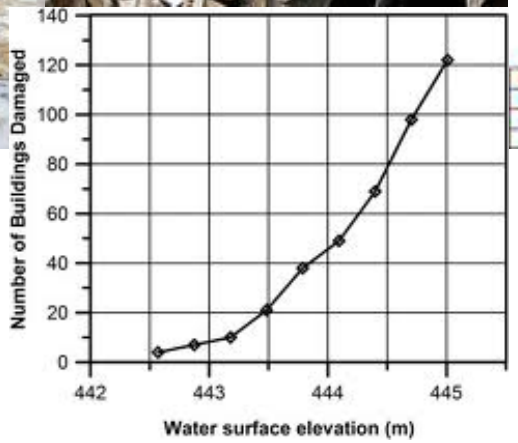


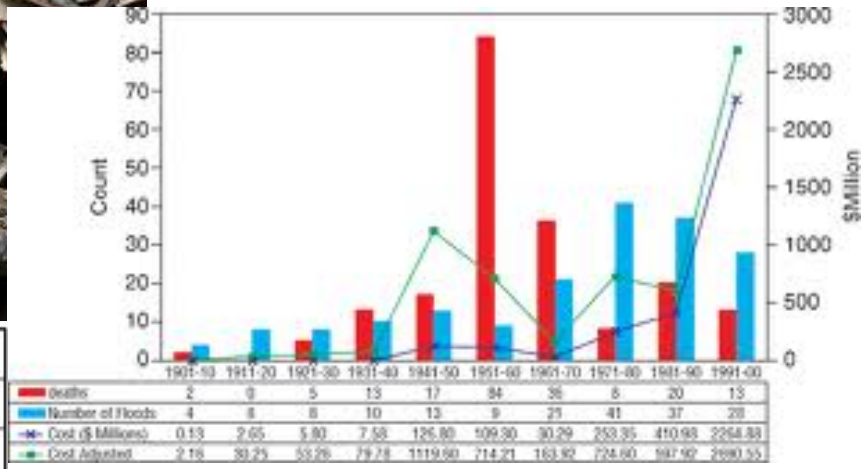
Annual flood peak graph



Flood Frequency Curve

Measuring Flood Damage





Damage vs Magnitude Graphs

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Factors in Flood Damage

- Magnitude
- Timing
- Location
- Population
- Land value

Other Sources of Information for Determining Flood Risk

Risk Information – monetary

- Insurance information
- Estimation of crop value at time of flood
- Estimate of replacing houses and other property
- Cost of replacing civic infrastructure
- Estimates of lost productivity
- Cost of disaster recovery

Other Sources of Information for Determining Flood Risk

Risk Information – social

- Increased poverty – numbers of people or severity
- Loss of access to social services and estimated costs
- Damage due to loss of livelihood – permanent or temporary
- Cost of losses due to reduced health
- Cost of health care itself

Risk Analysis

Result of analysis: Expected Damage Functions

Return Period (years)	Magnitude (m^3/sec)	Damage ($ million)
1:1	25	0
1:2	50	0.5
1:5	150	1.0
1:25	500	2.0
1:50	750	6.0
1:100	2000	12.0
1:1000	10000	25.0

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Droughts and Risk

Definitions:

- ***Drought -*** a condition of the cumulative impacts of several dry years on water users and on the general population.

- **Dry Year –** dry years occur, but are not droughts. Irrigation planning is based on a 1:5 year dry period.

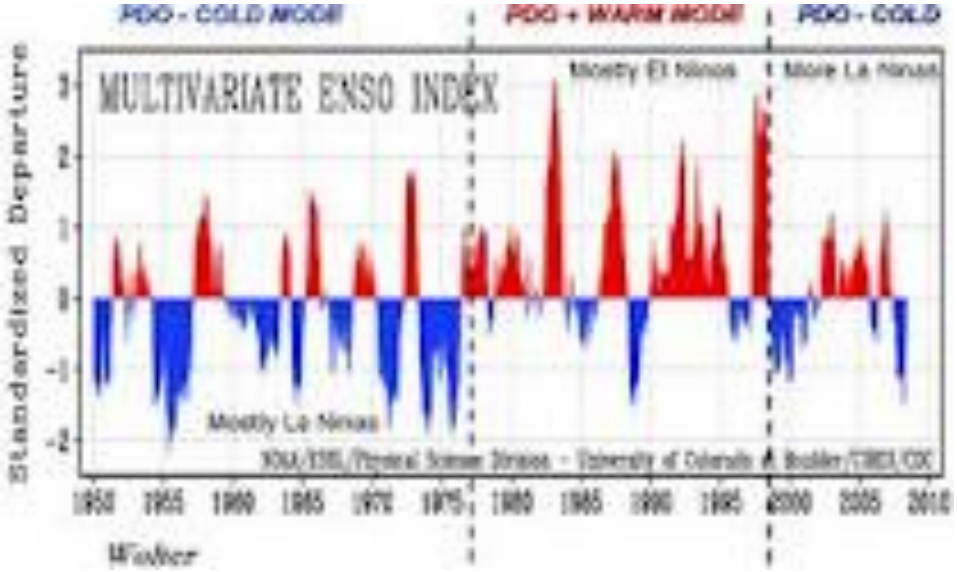
Droughts and Risk

- ***Impacts or damage*** – water availability, food security, health, livelihoods, environment .
- Damage tends to be widespread, covering countries, even continents

Droughts and Risk

- **Drought magnitude** – a condition which worsens with time, because of the time.
- **Drought extent** – droughts tend to cover large areas at one time because the weather phenomena which cause them are large scale.
- **Drought frequency** – similar to floods but the statistics are different.

Droughts tend to occur in cycles.



Risk Analysis for Droughts

Similar to analysis for floods

Risk = p(event occurring) X (cost if the event occurs)

- More widespread
- Often more people affected
- Costs or losses tend toward social impacts

Part 2

1. Flood management: reducing risks and mitigating damage
2. Drought management approaches
3. Case studies – Red River Flooding

Managing Flood Risk

Structural measures:

- Dams: specific to flood peak reduction
- Dams: multiobjective
- Flood embankments
- Channel ‘improvements’
- Flood plain inundation

Managing Flood Risk

Structural measures:

Kish River Azerbaijan

Managing Flood Risk

Non-structural measures:

- Flood mapping and zoning
- Flood zones and regulation
- Flood forecasting
- Early warning

Managing Flood Risk

Integrated Flood Management:

Part of a <u>national</u> approach to flood management

<u>Aim:</u> to improve the function of the river basin as a whole, recognizing that losses may occur due to interactions between the water and land environments and people.

<u>Objective:</u> to reduce losses from floods while optimizing the efficient use of flood plains.

Managing Flood Risk

Integrated Flood Management is <u>forward planning</u>

- doing what is possible before it happens

Reducing risk and vulnerability:

- Maintaining safety in a flood plain
- Flood zoning – must be area specific
- Community based and participatory

Managing Flood Risk

Integrated Flood Management is <u>forward planning</u>

- doing what is possible before it happens

Reducing risk and vulnerability:

- Early warning
- Disaster preparedness plans in place – must be area specific
- Community based and participatory

Managing Flood Risk

Integrated Flood Management is <u>forward planning</u>

- doing what is possible before it happens

Reducing flood magnitude:

- land use planning and regulations
- includes river channel
- structures in place

Managing Flood Risk

Integrated Flood Management is <u>forward planning</u>

During the event:

- Ensuring flood warning is received and understood
- Enacting the disaster preparedness plan
- Maintaining communications

Managing Flood Risk

Integrated Flood Management is <u>forward planning</u>

After the event: part of the disaster preparedness plan

- Emergency services – health and welfare (rapid)
- Restoration of services: water, communications, transport (relative short term)
- Rehabilitation of affected area (may be years)

Flood Management

Strategy	Options
Reducing Flooding	Dams and reservoirs
	Dikes, flood embankments
	High flow diversions
	Catchment management
	Channel improvements
Reducing Susceptibility to Damage	Flood plain regulation
	Development policies
	Design and location of facilities
	Housing and building codes
	Flood-proofing
	Flood forecasting and warning
Mitigating the Impacts of Flooding	Information and education
	Disaster preparedness
	Post flood recovery
	Flood insurance
Preserving Natural Resources	Flood plain zoning and regulation

Managing Flood Risk

Integrated flood management:

- Combining structural and non-structural
- Requires good management, good institutions
- Community participation (flood zone mapping, early warning, disaster preparedness plan)

Managing Flood Risk

Governance and Institutions:

- Capacity of government institutions (including local)
- Flood management plans in place for mitigation, damage reduction, rescue, rehabilitation, etc.
- Laws and regulations, especially zoning

Managing Drought Risk

Managing droughts - different from floods in:

- More widespread
- Often many people affected, nowhere for them to go
- Most affected people are poor
- Primary losses are social – life, livelihood, health

Also:

- Warning time is much longer

Managing Drought Risk

Measures for drought management:

Before the event occurs:

Early warning:

- some expectation due to knowledge of cycles and drought prone areas
- drought preparedness plans – mostly social and emergency

Managing Drought Risk

Measures for drought management:

Through the event (long warning time):

- Initial stage – concern but not yet damaging - reduce water use
- Medium stage – damaging but not yet disaster - water transfers (unlikely)
- Long term – disaster - procedures for saving lives – food and water aid

Managing Drought Risk

Measures for drought management:

After the event:

- Restoration livelihoods
- Restoring land

Case Study: Red River Floods

Case Study: Red River Floods

Historical Red River Floods

Year	flow (m^3/sec)	T_r	Year	flow (m^3/sec)	T_r
1826	6371	667	1966	2497	14
1852	4672	150	1969	2143	8
1861	3540	45	1970	2251	10
1882	2421	13	1974	2718	19
1892	1974	7	1979	3030	27
1897	1954	7	1987	2350	12
1904	2209	9	1996	3058	25
1916	2427	13	1997	4615	110
1948	2124	8	1999	2183	9
1950	3060	28	2006	2802	16
1956	1974	7	2009	3622	48
1960	1965	7	2010	3962	75
			2011	4223	120

Case Study: Red River Floods

Major Floods	
Since the first flood record: 1826	25
In 20th century	19
In last half century	13
In last 25 years	8
This century so far	4

Flood Magnitude:

4 of top 10 floods in this century

Case Study: Red River Floods

Why do people stay?

Rich farmland

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Case Study: Red River Floods

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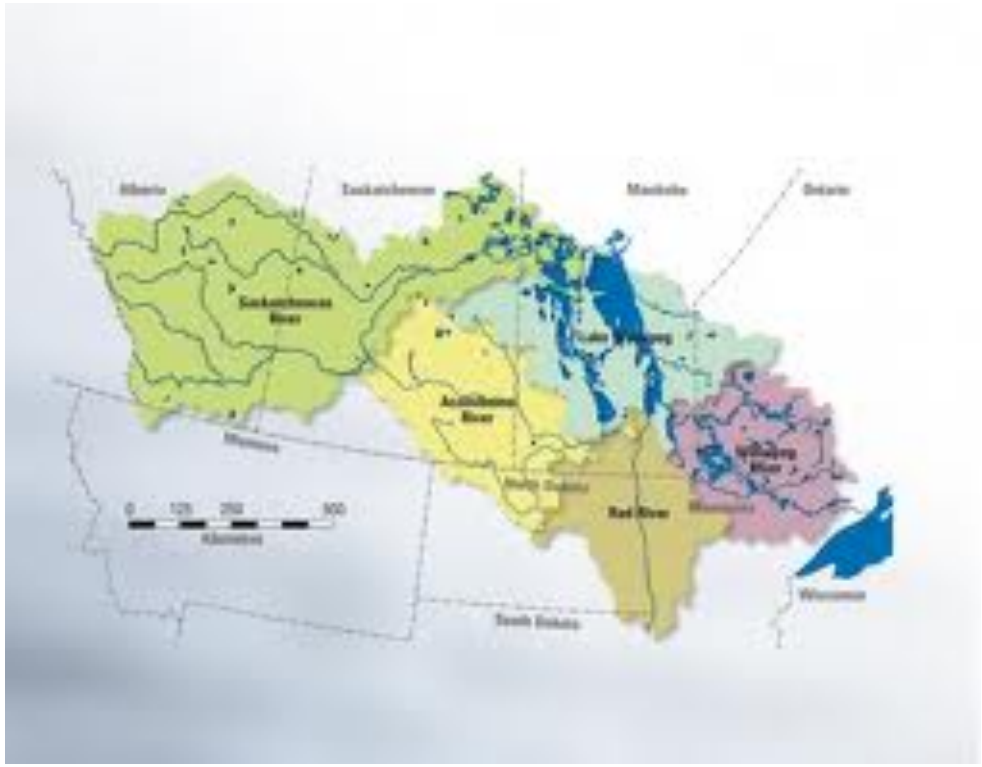
Case Study: Red River Floods

- *Transboundary river*
- *Spring floods*
- *Flows south to north*



Ice Jamming

- Increases flood crest
- Increases risks
- Increases damage

Case Study: Red River Floods

Flood forecasting and early warning:

- *Cooperative across the border*
- *Forecasting starts in late autumn for spring floods*
- *Revisions through the winter*
- *Intensity and frequency of forecasts increases as flood period approaches.*
- *Daily and hourly if a flood is expected – TV, radio, internet*

Case Study: Red River Floods

Flood preparedness: before

Winnipeg Floodway

Design Flood 1:250 years

Case Study: Red River Floods

Flood preparedness - before:

Case Study: Red River Floods

Flood preparedness: during

Volunteers assist

Case Study: Red River Floods

Transboundary flood forecasting:

US National Weather Service

http://www.crh.noaa.gov/fgf/

Manitoba government flood service

http://www.gov.mb.ca/mit/floodinfo/