ASSESSMENT OF ENVIRONMENTAL FLOW BY HYDROLOGICAL APPROACH IN MYITNGE RIVER BASIN

Presenter
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Environmental flow

- Enough water that is left in the river, or release into it to manage downstream environmental, social and economic benefits. (Dyson et al., 2008)

- Quantity, quality and timing of water flows required to sustain freshwater , ecosystem and human livelihoods and well-being that depend on these ecosystem. (Richter et al.,2003)

STUDY AREA

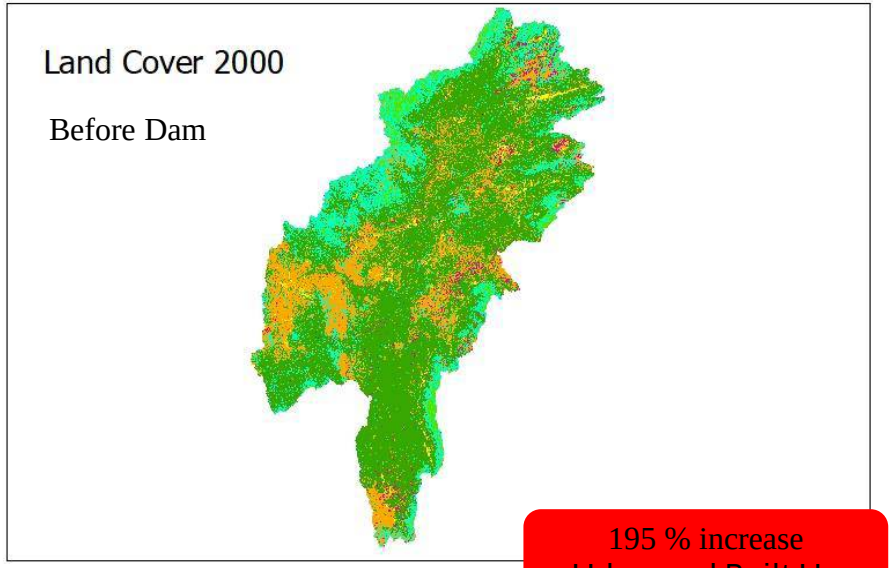
Catchment area	28206 km2
Annual mean discharge at dam site	483 m3/sec
Full supply level	EL 185 m
Minimum operation level	EL 150 m
Gross storage capacity	2611 MCM
Dead storage capacity	992.8 MCM
Installed capacity	790 MW (197.5 x 4 units)
Maximum plant discharge	210 m3/sec
Rated head	91m
Average Annual Energy	3550 GWh

Data Length

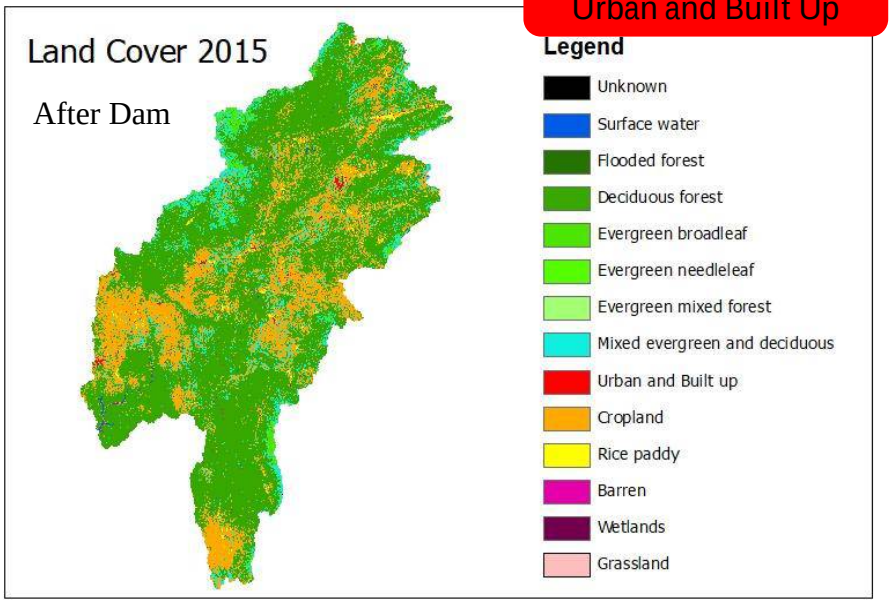
Before Dam 1981 2010

After Dam 2011 2017

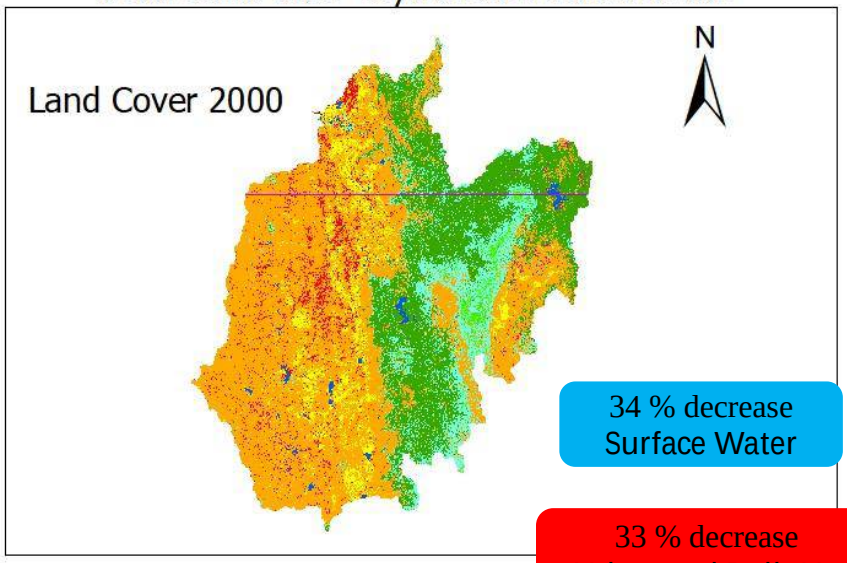
Land Cover Changes of Myitnge River Upstream before and after Yeywa Dam Construction



195 % increase
Urban and Built Up

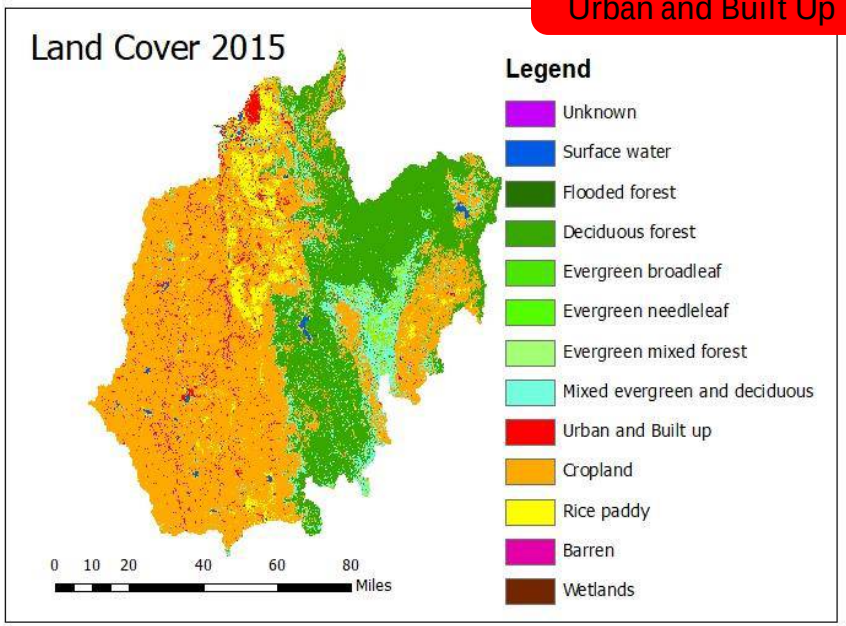


Land Cover Changes of Myitnge River Downstream before and after Yeywa Dam Construction

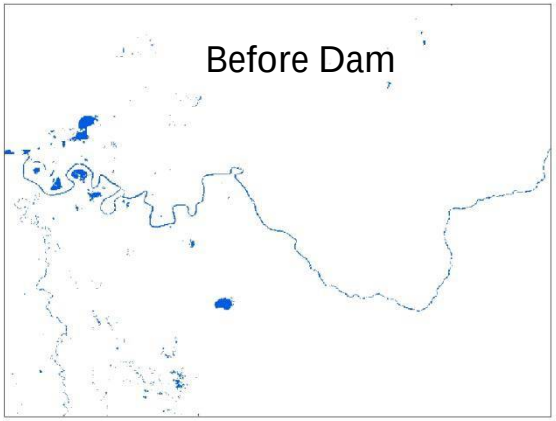


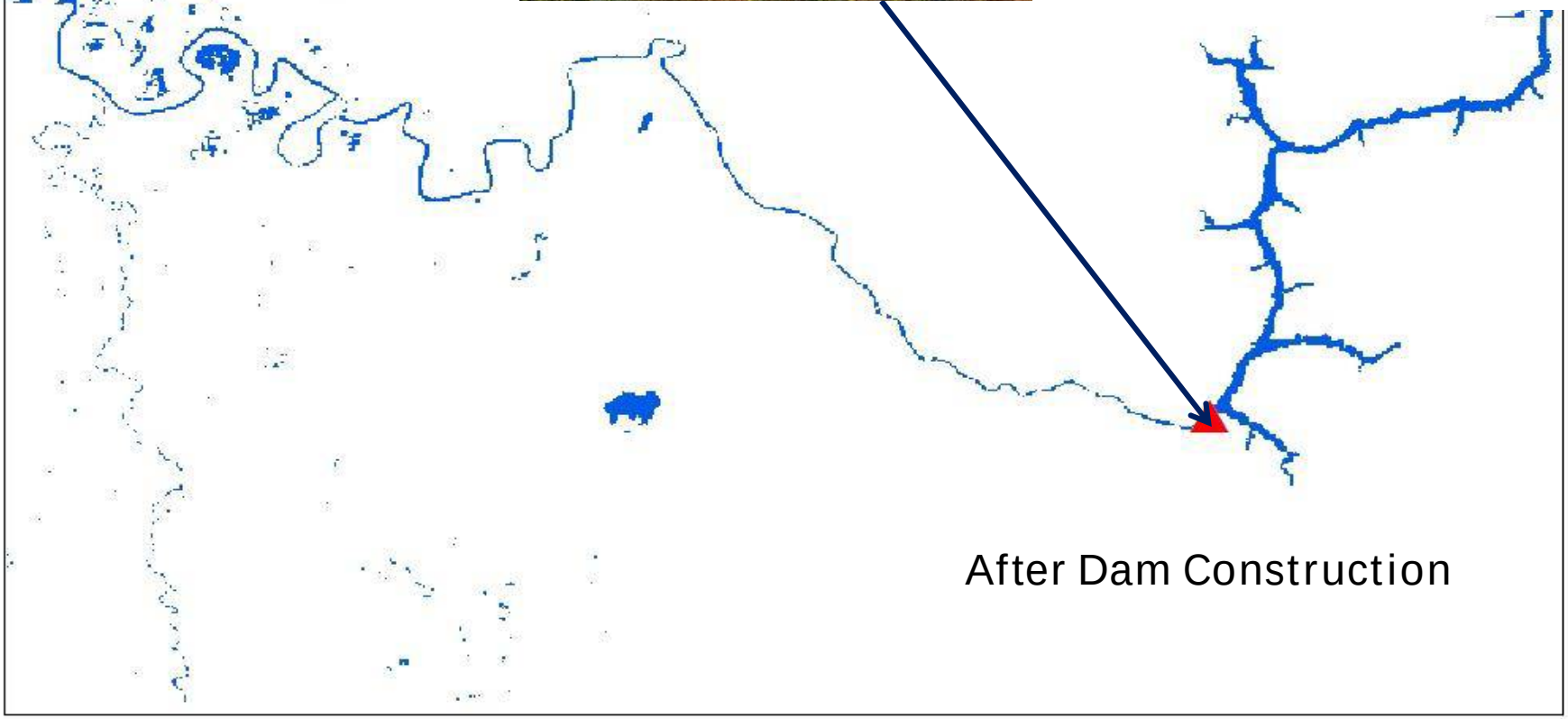
34 % decrease
Surface Water

33 % decrease
Urban and Built Up

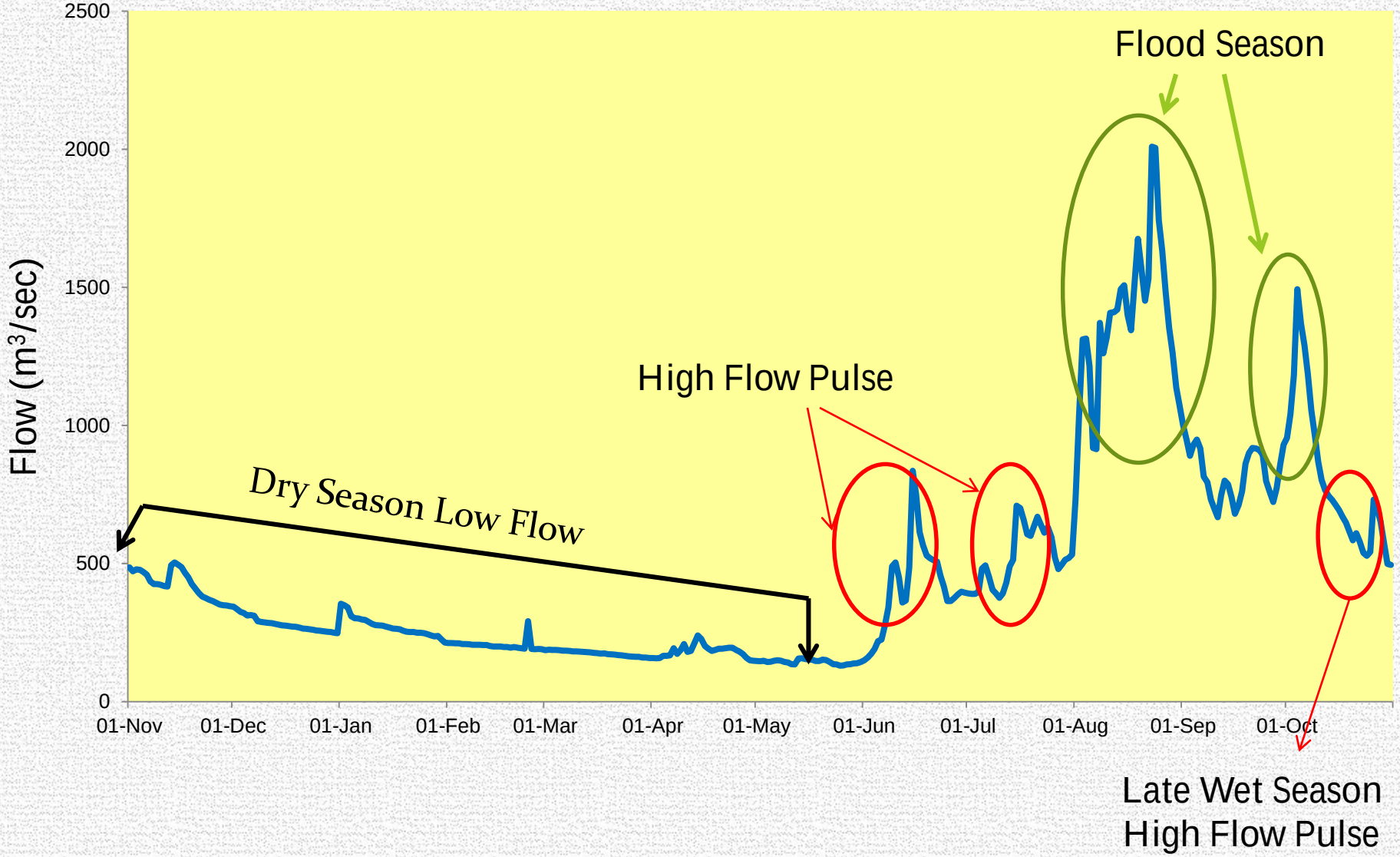


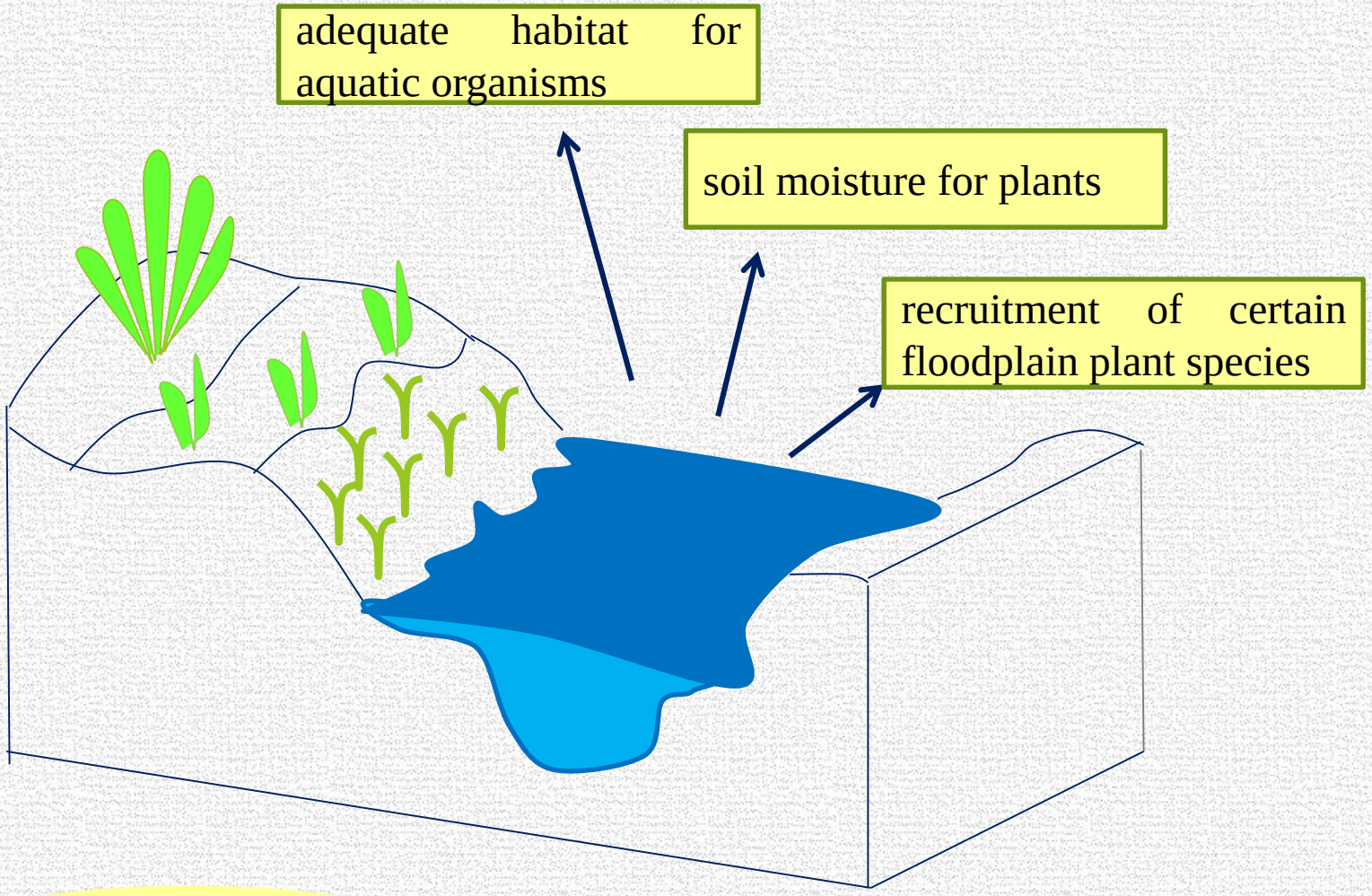
Downstream water body after dam decrease 34% of natural river body.





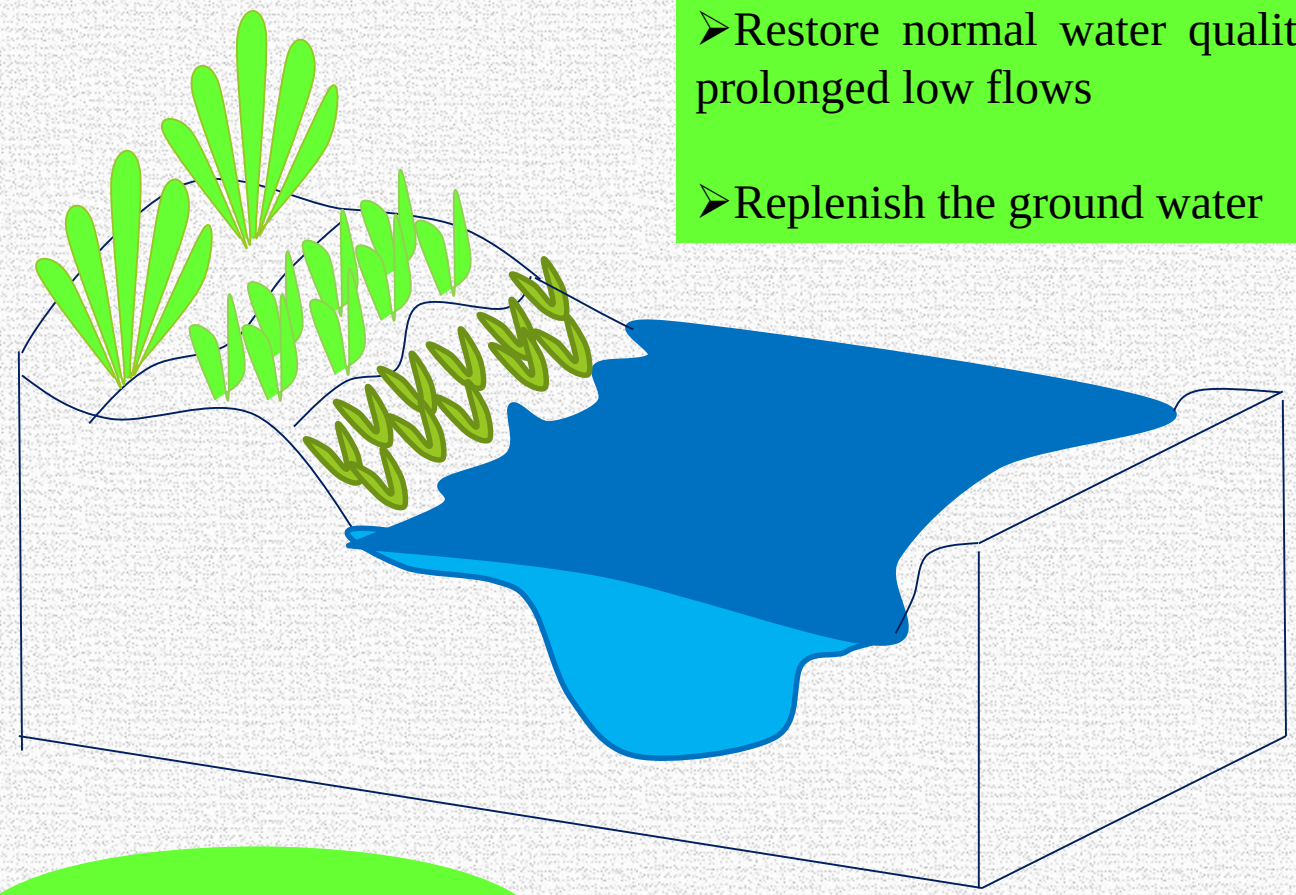
Hydrograph of Myitnge River without Yewa Dam (1982)




adequate habitat for aquatic organisms
soil moisture for plants
recruitment of certain floodplain plant species

Low Flow

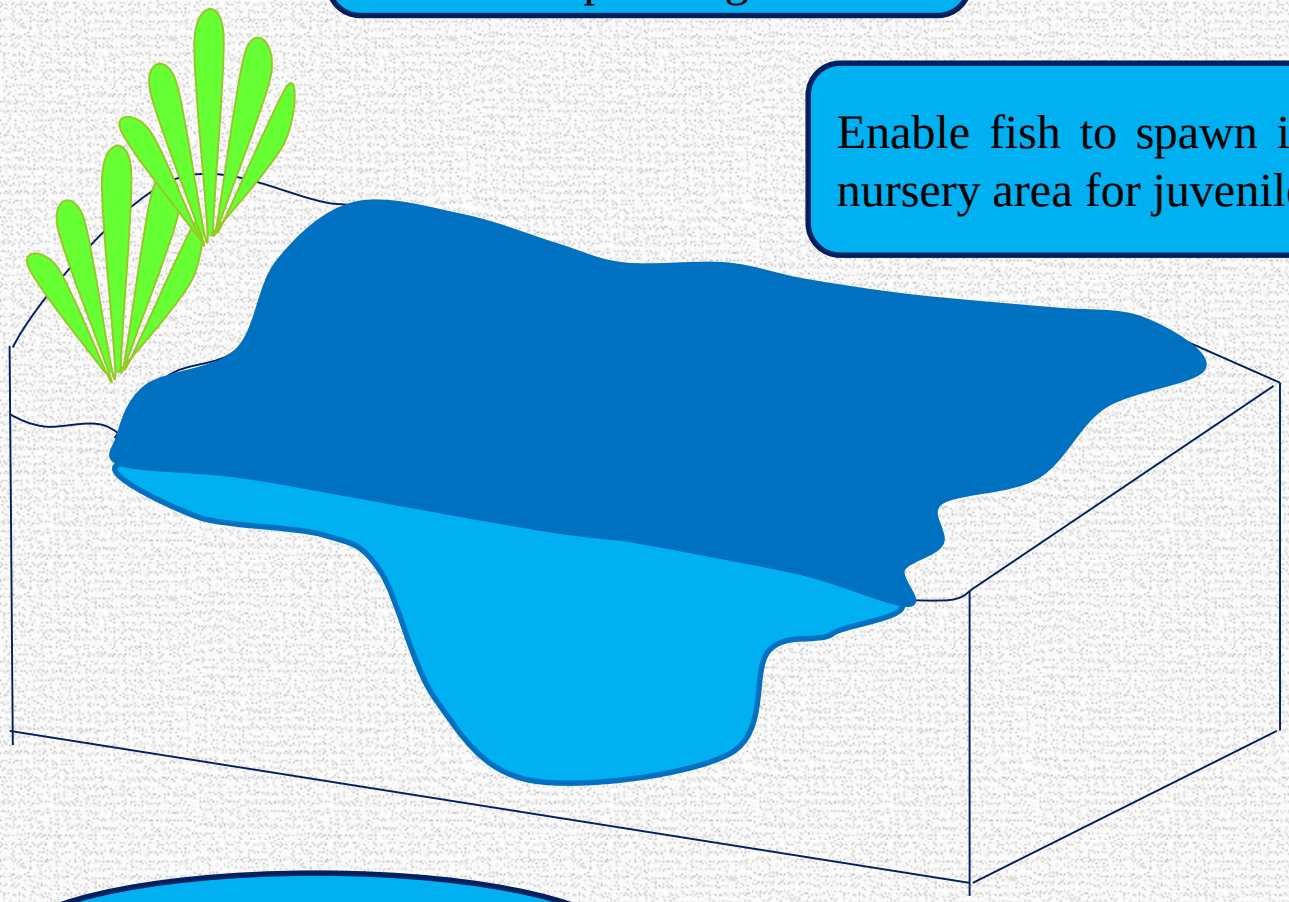
- Shape physical character of river channel, including pools, riffles
- Restore normal water quality conditions after prolonged low flows
- Replenish the ground water



High Flow

Deposit nutrients rich on floodplain and gravel and cobbles in spawning areas

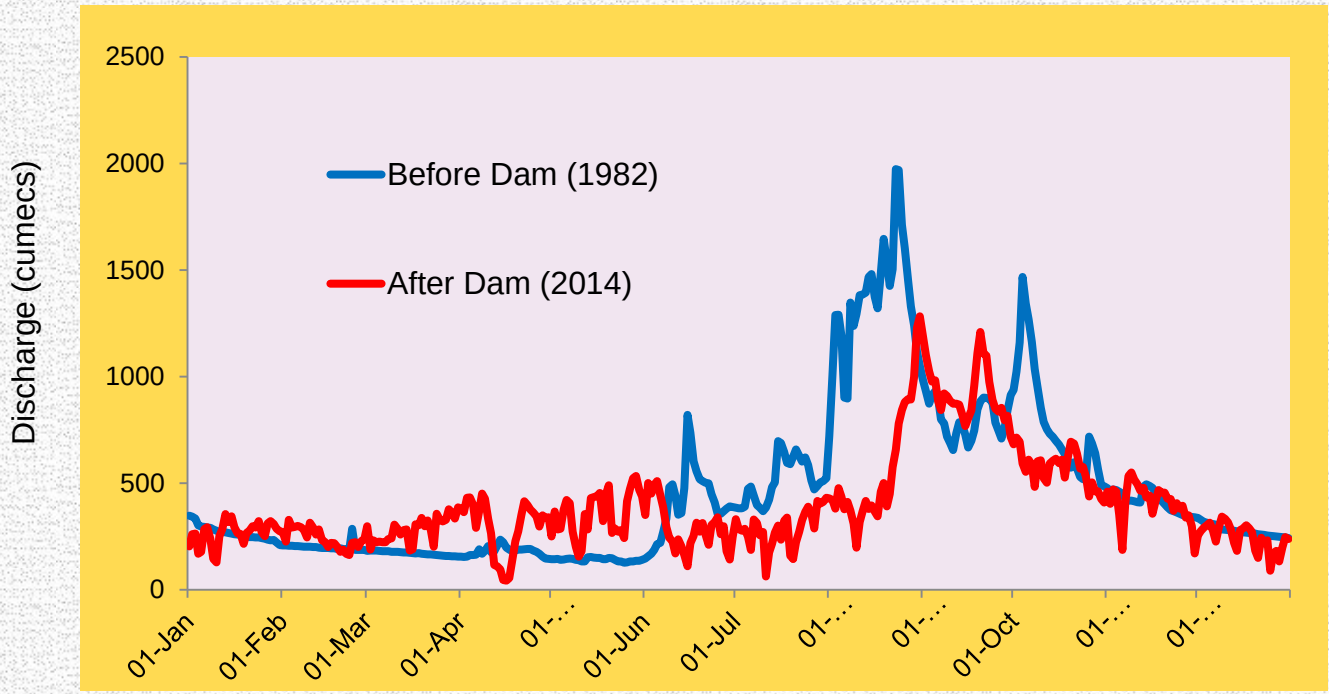
Enable fish to spawn in floodplain, provide nursery area for juvenile



Recharge floodplain water table

Flood

Hydropower Impact on Flow after YEYWA Dam Construction



1. Many fluctuation
2. Seldom /Loss of floods
3. Less frequent high flow pulse

Environmental Flow Assessment Method

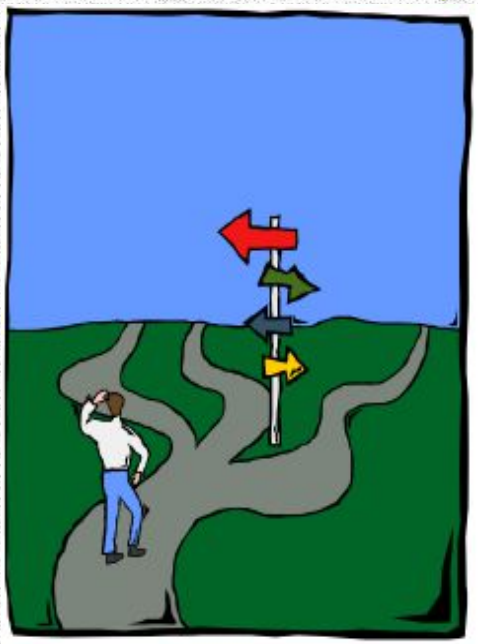
Method Type	Example Methods	Data needs
Hydrological index method	• Tennant • Tessman • Flow Duration Curve(FDC) • Global Environmental Flow Calculator (GEFC) • Integrated Hydrologic Alteration(IHA) • Dundee Hydrological Regime Assessment Method (DHRAM)	▪ Historical flow records
Hydraulic rating method	• Wetted Perimeter • R2 cross	▪ Historical flow records ▪ Hydraulic variables- single cross-section
Habitat simulation method	• In-Stream Flow Incremental Methodology (IFIM) • Physical HABitat SIMulation model (PHABSIM)	▪ Historical flow records ▪ Hydraulic variables- multiple cross-section ▪ Biological data
Holistic method	• Building Block Methodology (BBM) • Downstream Response to Imposed Flow Transformation (DRIFT)`	▪ Historical flow records ▪ Hydraulic variables- multiple cross-section ▪ Biological data ▪ Ecological data

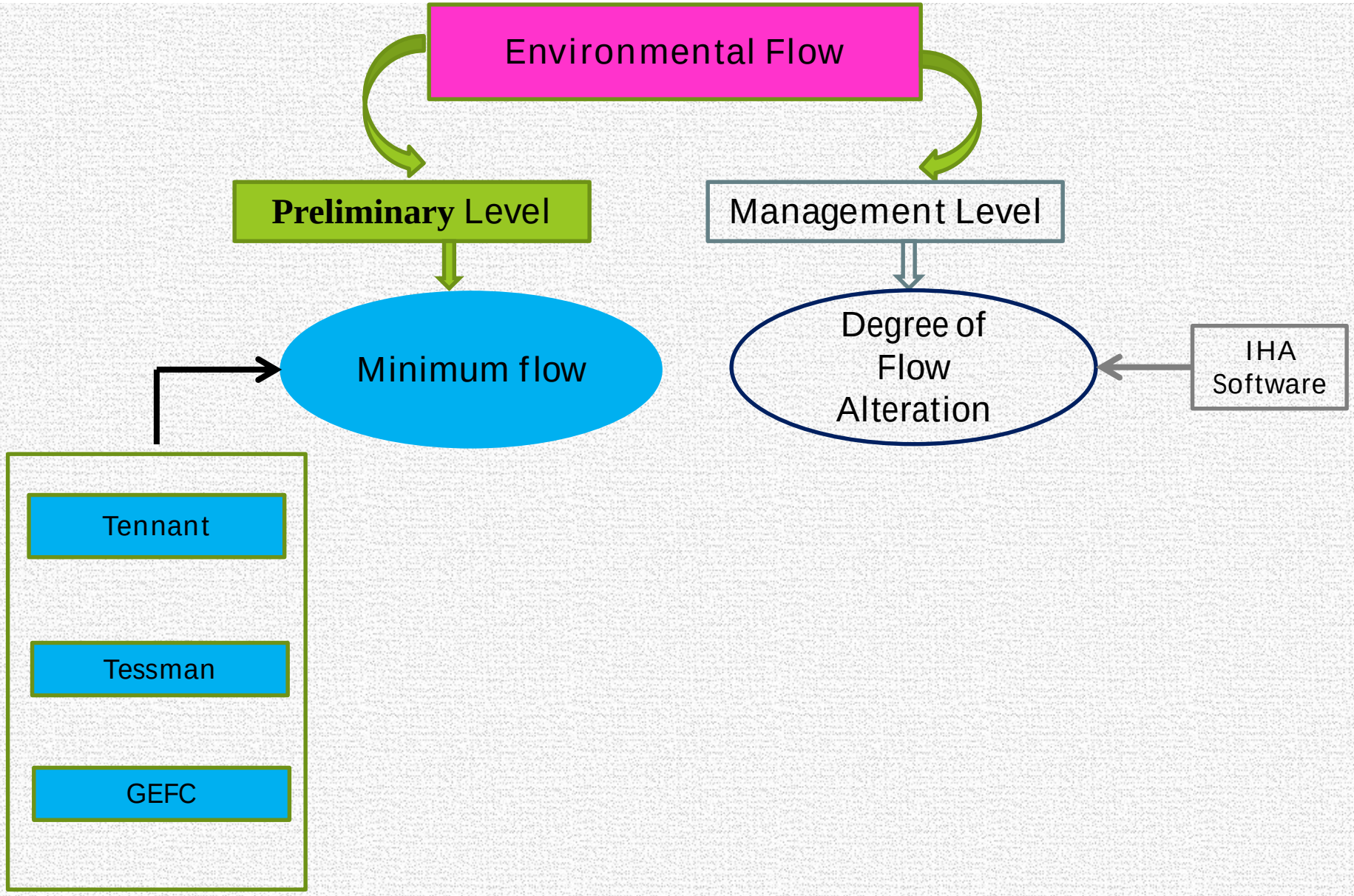
Acreman & Dunbar, 2004, Dyson et al., 2008) and Tharme (2003)

METHODOLOGY

Hydrological Index Method

- Data Availability




Environmental Flow
Preliminary Level
Management Level
Minimum flow
Degree of Flow Alteration
IHA Software
Tennant
Tessman
GEFC

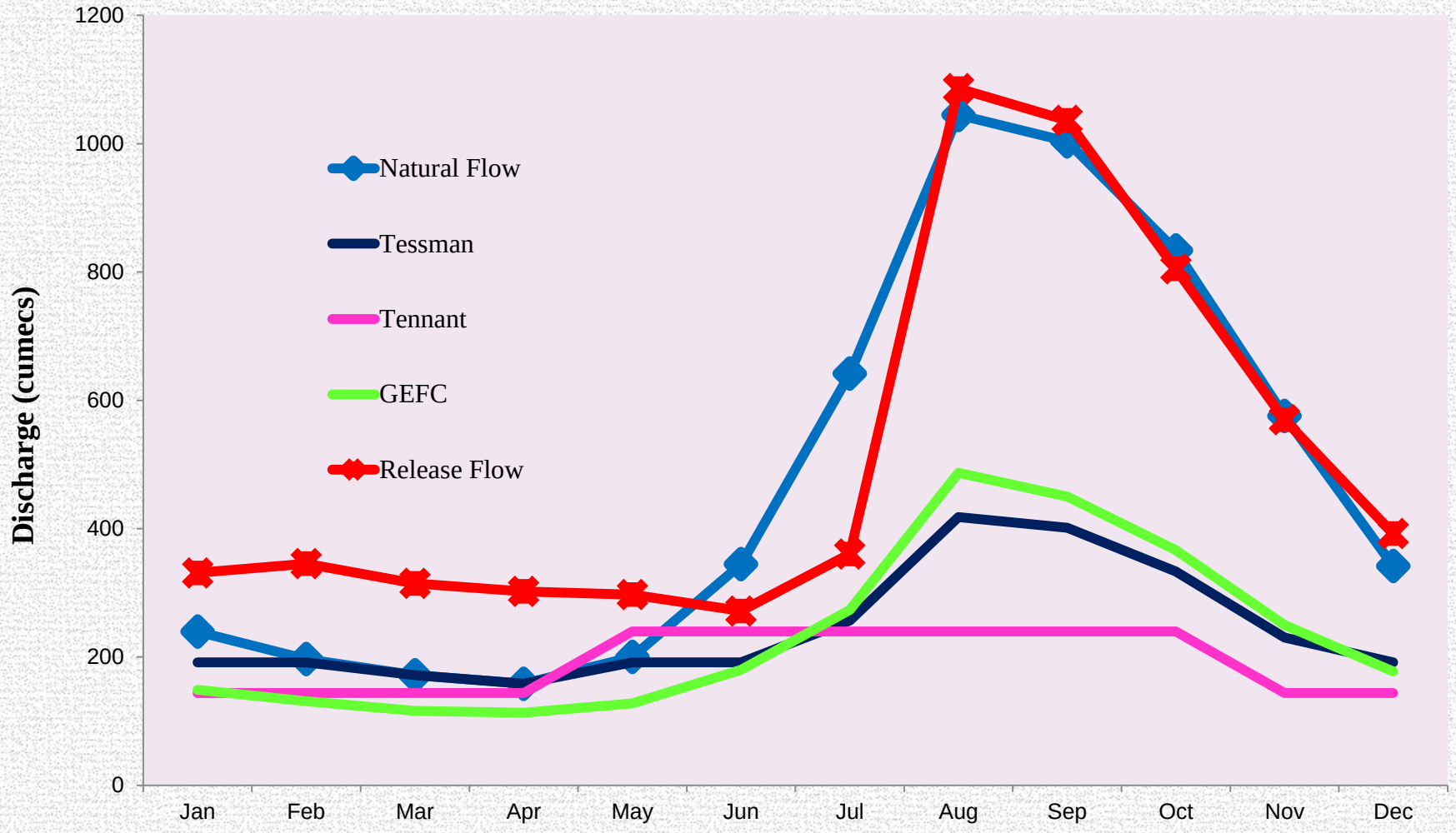
Global Environmental Flow Calculator (GEFC)

EMC	Management Perspective
A. Natural	Not allow new water projects (dams, diversions, etc.)
B. Slightly Modified	Allow water supply schemes or irrigation development
C. Moderately Modified	**Multiple disturbances associated with the need for socio-economic development, eg: dams, diversions, habitat modification and reduced water quality.**
D. Largely Modified	Significantly disturbances associated with water resources development, including dams, diversion, transfers, habitat modification and water quality degradation
E. Seriously Modified	High human population density and extensive water resources exploitation
F. Critically Modified	This status is not acceptable from the management perspective.

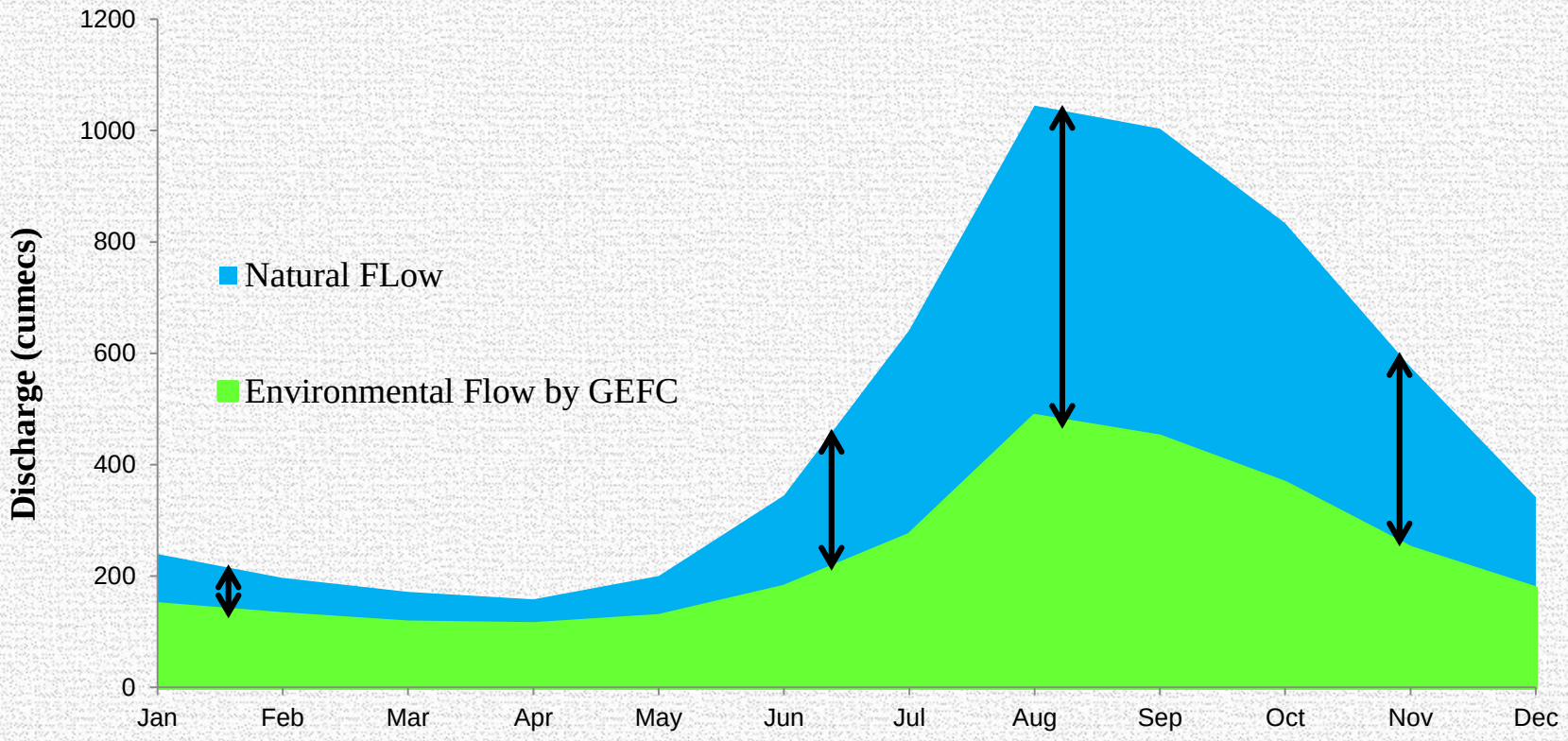
Ecological Description

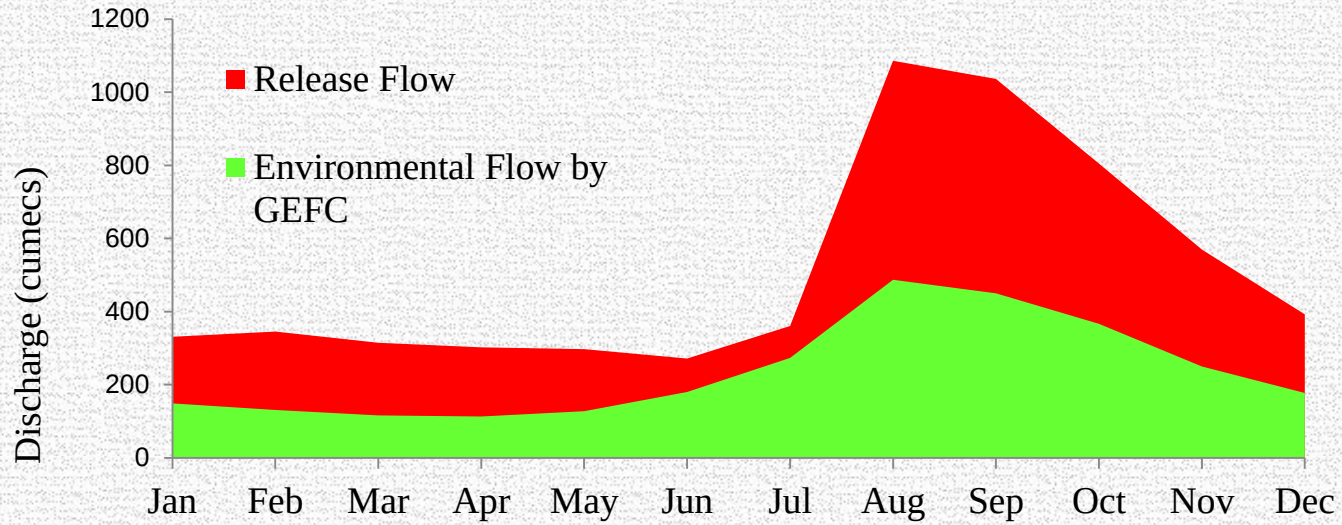
- Basic ecosystem functions are still intact
- Some sensitive species are lost and/or reduced in extent.

Minimum Environmental Flow (m^3/sec)

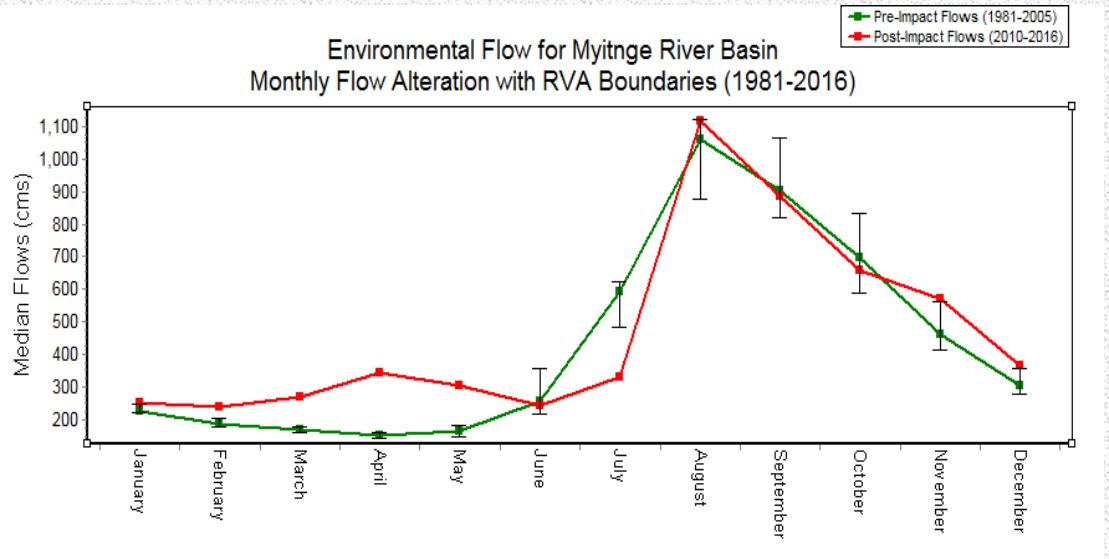


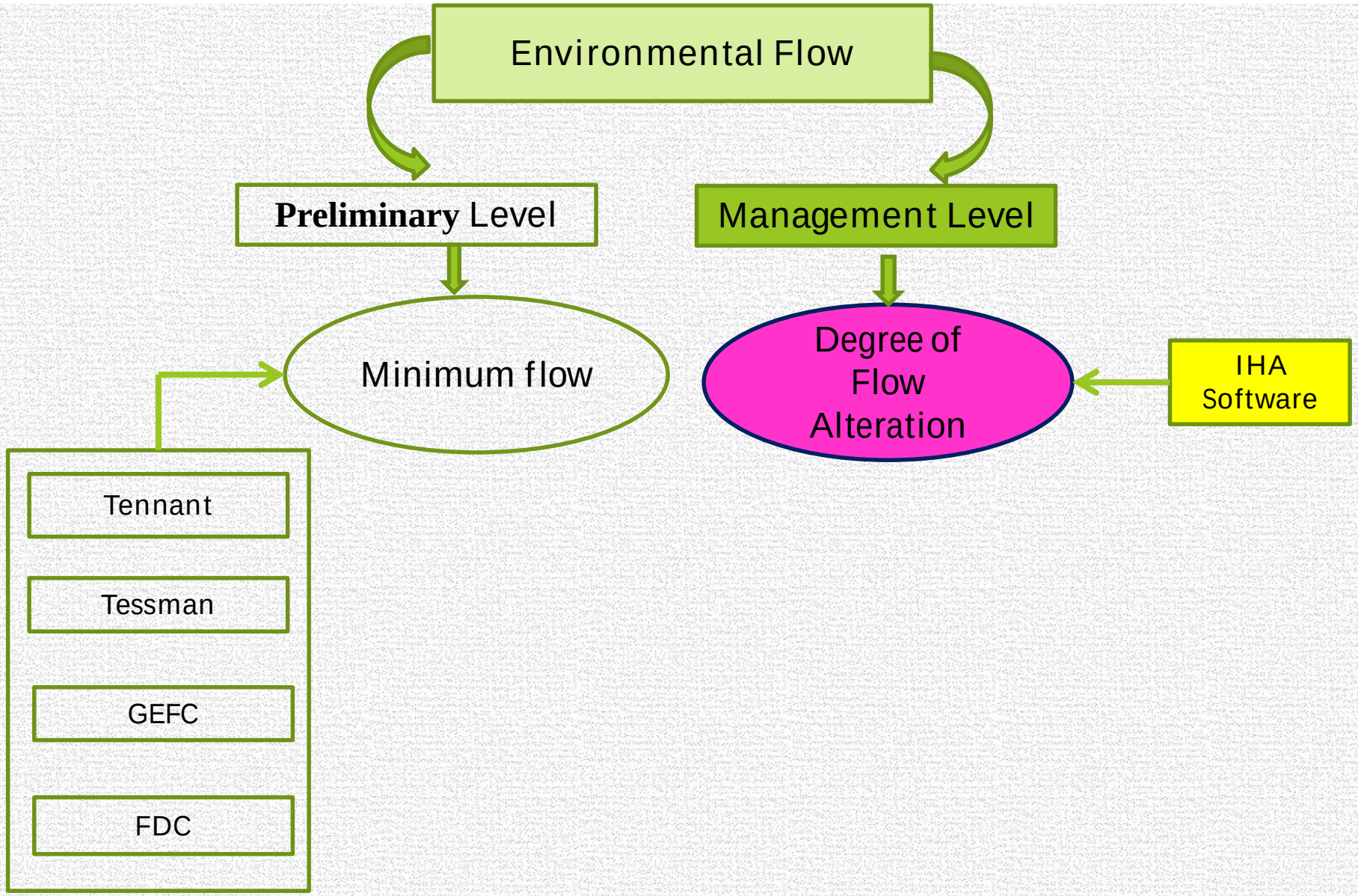
Recommended Environmental Flow





The target of environmental flow is that the released hydrograph falls within the limited flow regime from natural hydrograph after fulfill the minimum environmental flow requirement.




Environmental Flow
Preliminary Level
Management Level
Minimum flow
Degree of Flow Alteration
IHA Software
Tennant
Tessman
GEFC
FDC

Environmental Flow Assessment in Management Level

Indicators of Hydrological Alteration (IHA)

- Total of 67 statistical parameters
- 34 Environmental Flow Component (EFC)
- 33 IHA

EFC

To assess the Environmental Flow range

1. Low flow
2. Extreme low flow
3. High flow
4. Small flood
5. Large flood

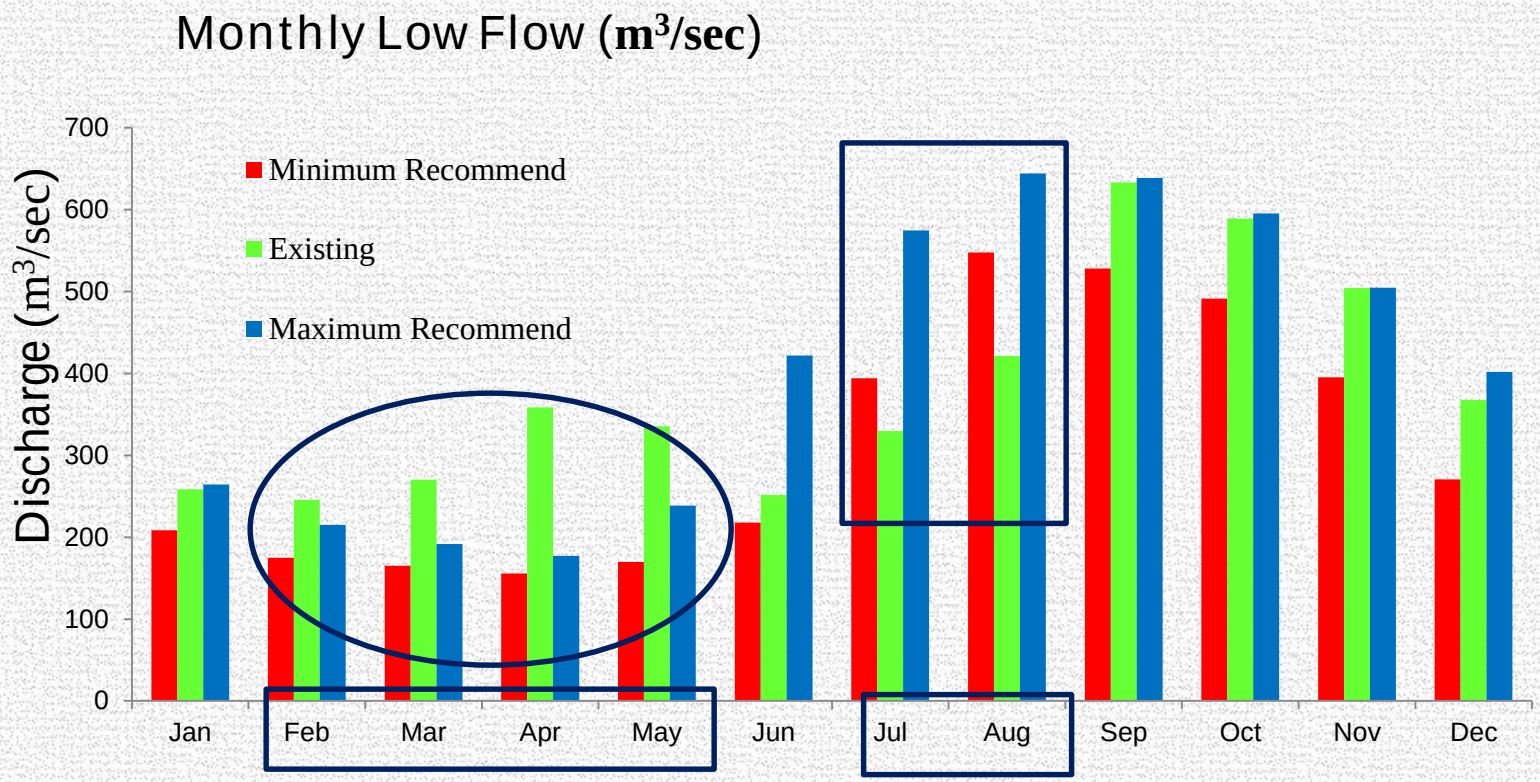
- Magnitude
- Duration
- Timing
- Frequency
- Rate of change

IHA

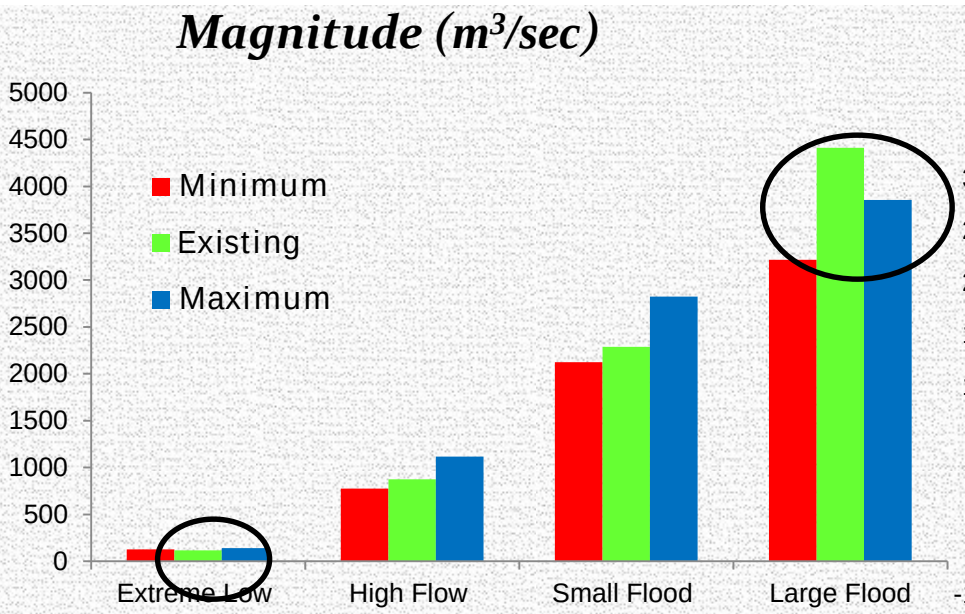
To quantify the flow alteration degree before and after dam construction

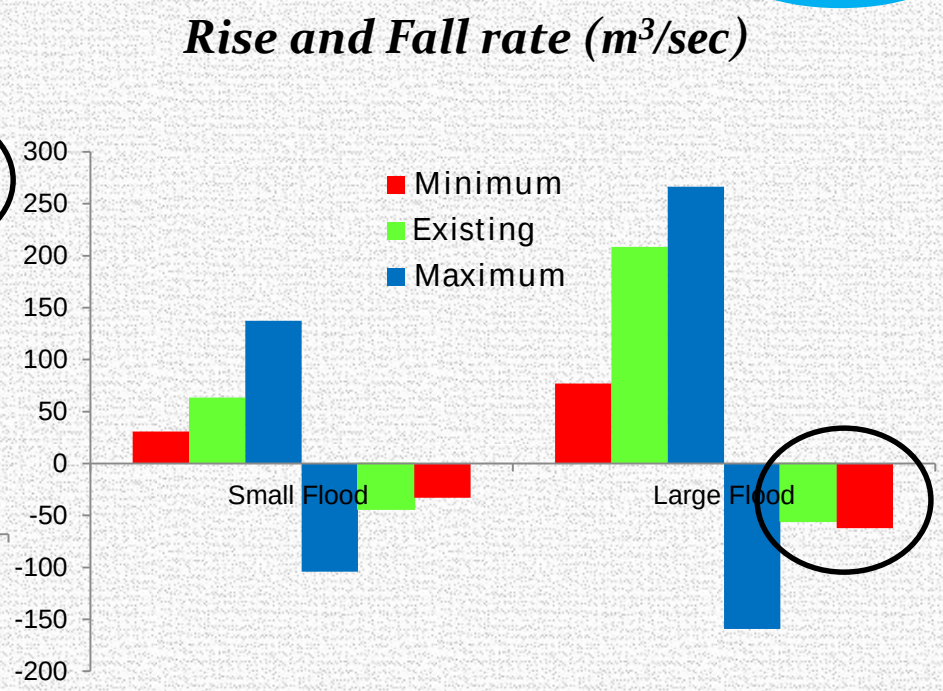
Comparison of Existing Released Flow with Recommended Flow

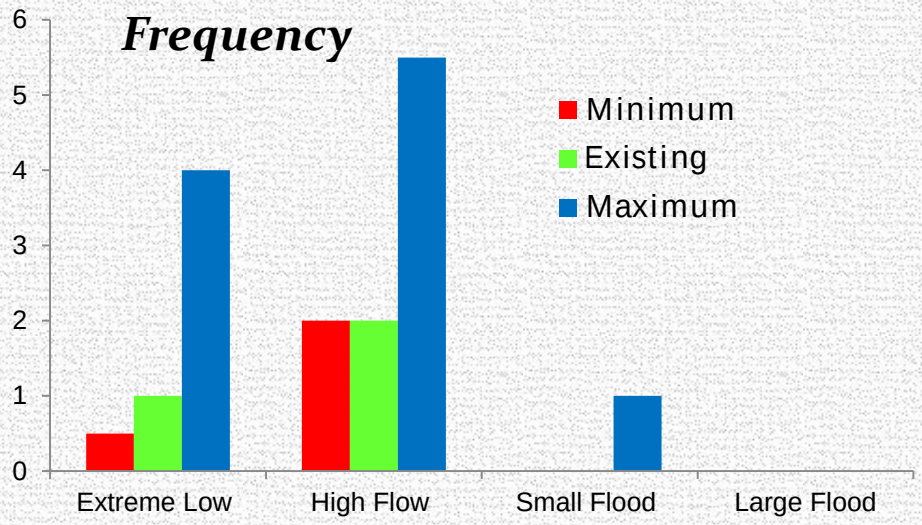
EFC

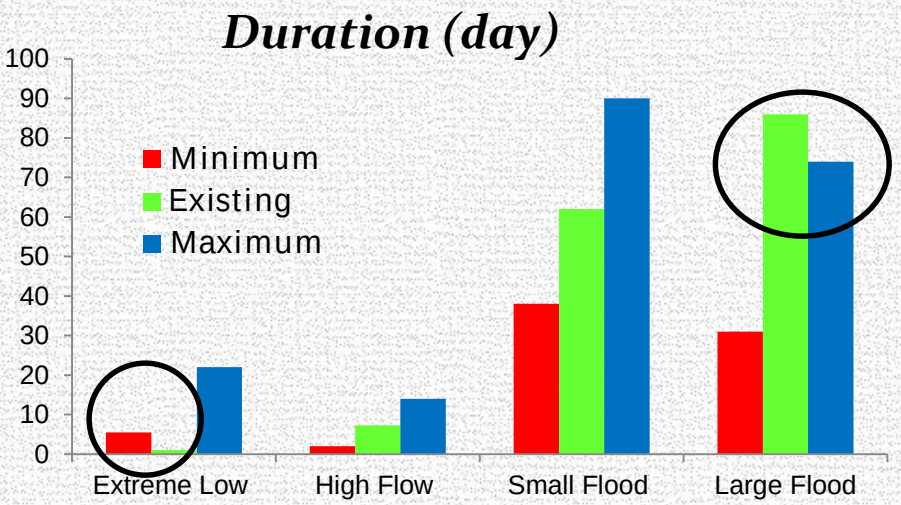


EFC


Magnitude (m³/sec)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Minimum
Existing
Maximum
Extreme Low
High Flow
Small Flood
Large Flood


Rise and Fall rate (m³/sec)
300
250
200
150
100
50
0
-50
-100
-150
-200
Minimum
Existing
Maximum
Small Flood
Large Flood


Frequency
6
5
4
3
2
1
0
Minimum
Existing
Maximum
Extreme Low
High Flow
Small Flood
Large Flood


Duration (day)
100
90
80
70
60
50
40
30
20
10
0
Minimum
Existing
Maximum
Extreme Low
High Flow
Small Flood
Large Flood

EFC

Timing (Julian Date)

Extreme Low Flow

Untimely

Small Flood

Large Flood

High Flow

Untimely

January							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
52							1
1	2	3	4	5	6	7	8
2	9	10	11	12	13	14	15
3	16	17	18	19	20	21	22
4	23	24	25	26	27	28	29
5	30	31					

February							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
5			1	2	3	4	5
6	6	7	8	9	10	11	12
7	13	14	15	16	17	18	19
8	20	21	22	23	24	25	26
9	27	28					

March							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
9			1	2	3	4	5
10	6	7	8	9	10	11	12
11	13	14	15	16	17	18	19
12	20	21	22	23	24	25	26
13	27	28	29	30	31		

April							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
13						1	2
14	3	4	5	6	7	8	9
15	10	11	12	13	14	15	16
16	17	18	19	20	21	22	23
17	24	25	26	27	28	29	30

May							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
18	1	2	3	4	5	6	7
19	8	9	10	11	12	13	14
20	15	16	17	18	19	20	21
21	22	23	24	25	26	27	28
22	29	30	31				

June							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
22				1	2	3	4
23	5	6	7	8	9	10	11
24	12	13	14	15	16	17	18
25	19	20	21	22	23	24	25
26	26	27	28	29	30		

July							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
26						1	2
27	3	4	5	6	7	8	9
28	10	11	12	13	14	15	16
29	17	18	19	20	21	22	23
30	24	25	26	27	28	29	30
31	31						

August							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
31		1	2	3	4	5	6
32	7	8	9	10	11	12	13
33	14	15	16	17	18	19	20
34	21	22	23	24	25	26	27
35	28	29	30	31			

September							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
35					1	2	3
36	4	5	6	7	8	9	10
37	11	12	13	14	15	16	17
38	18	19	20	21	22	23	24
39	25	26	27	28	29	30	

October							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
39							1
40	2	3	4	5	6	7	8
41	9	10	11	12	13	14	15
42	16	17	18	19	20	21	22
43	23	24	25	26	27	28	29
44	30	31					

November							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
44			1	2	3	4	5
45	6	7	8	9	10	11	12
46	13	14	15	16	17	18	19
47	20	21	22	23	24	25	26
48	27	28	29	30			

December							
Wk	Mo	Tu	We	Th	Fr	Sa	Su
48					1	2	3
49	4	5	6	7	8	9	10
50	11	12	13	14	15	16	17
51	18	19	20	21	22	23	24
52	25	26	27	28	29	30	31

33 Integrated Hydrologic Alteration parameters

IHA

Monthly Water Condition		Extreme Water Condition		Extreme Water Condition	
Jan	H	1-day minimum	H	Date of minimum	H
Feb	H	3-day minimum	M	Date of maximum	L
Mar	M	7-day minimum	M	High and Low Pulses	
Apr	H	30-day minimum	M	Low pulse count	H
May	M	90-day minimum	H	Low pulse duration	H
Jun	L	1-day maximum	M	High pulse count	L
Jul	H	3-day maximum	M	High pulse duration	L
Aug	L	7-day maximum	M	Water Condition Changes	
Sep	L	30-day maximum	L	Rise rate	L
Oct	L	90-day maximum	M	Fall rate	H
Nov	L	Number of zero day	-	Number of reversals	H
Dec	L	Base flow index	L		

11 High Alteration

9 Moderate Alteration

12 Low Alteration

A **single** integrated index ,D which is the average value of 32 degree of alteration for the 32 IHA parameters

$$D = \left(\frac{1}{32}\sum_{n=1}^{32} D_i^2\right)^{1/2}$$

Degree of Hydrologic alteration D = 67 % → Moderate Alteration: nearly High alteration

IHA Class →

0-33% = low alteration (L)
34-67% = moderate alteration (M)
68-100% = high alteration (H)

The objective of environmental flows is not reproduced a natural flow regime in whole, but rather to achieve a flow regime that maintains the essential processes required to support healthy river ecosystems.

Conclusion

- According to the existing condition, the released flow is fulfill the minimum environmental flow requirement .

- The degree of flow alteration after post-dam years due to existing hydropower policy is 67% that is a large scale. The river channel, habitats and aquatic species can be much negative impacts due to severely changed.

- So the reservoir operation rule should be developed for the benefit of hydro balancing between water user and environment by modifying the released flow condition.

THANK FOR YOUR ATTENTION