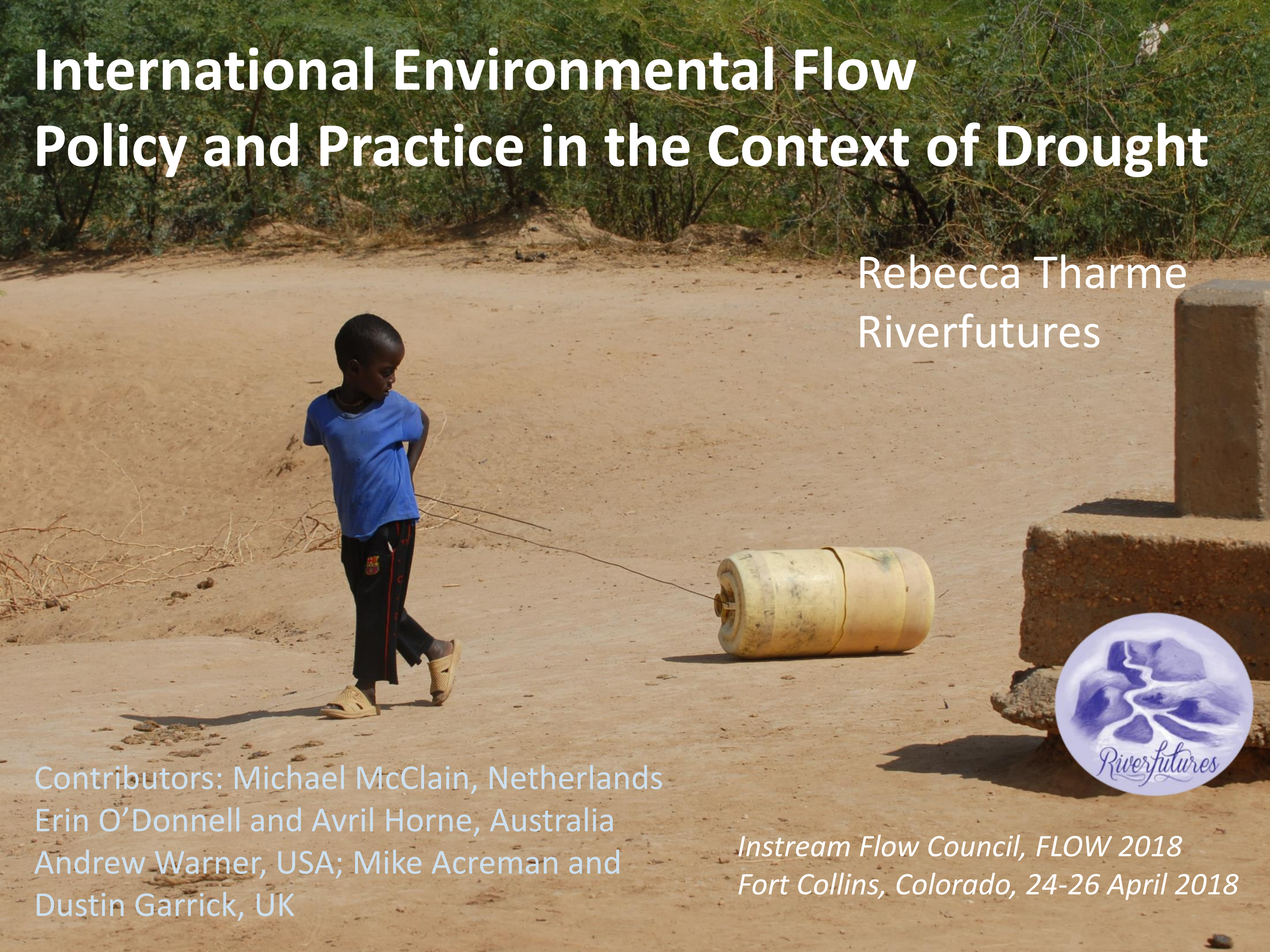


International Environmental Flow Policy and Practice in the Context of Drought

Rebecca Tharme
Riverfutures

Contributors: Michael McClain, Netherlands
Erin O'Donnell and Avril Horne, Australia
Andrew Warner, USA; Mike Acreman and Dustin Garrick, UK

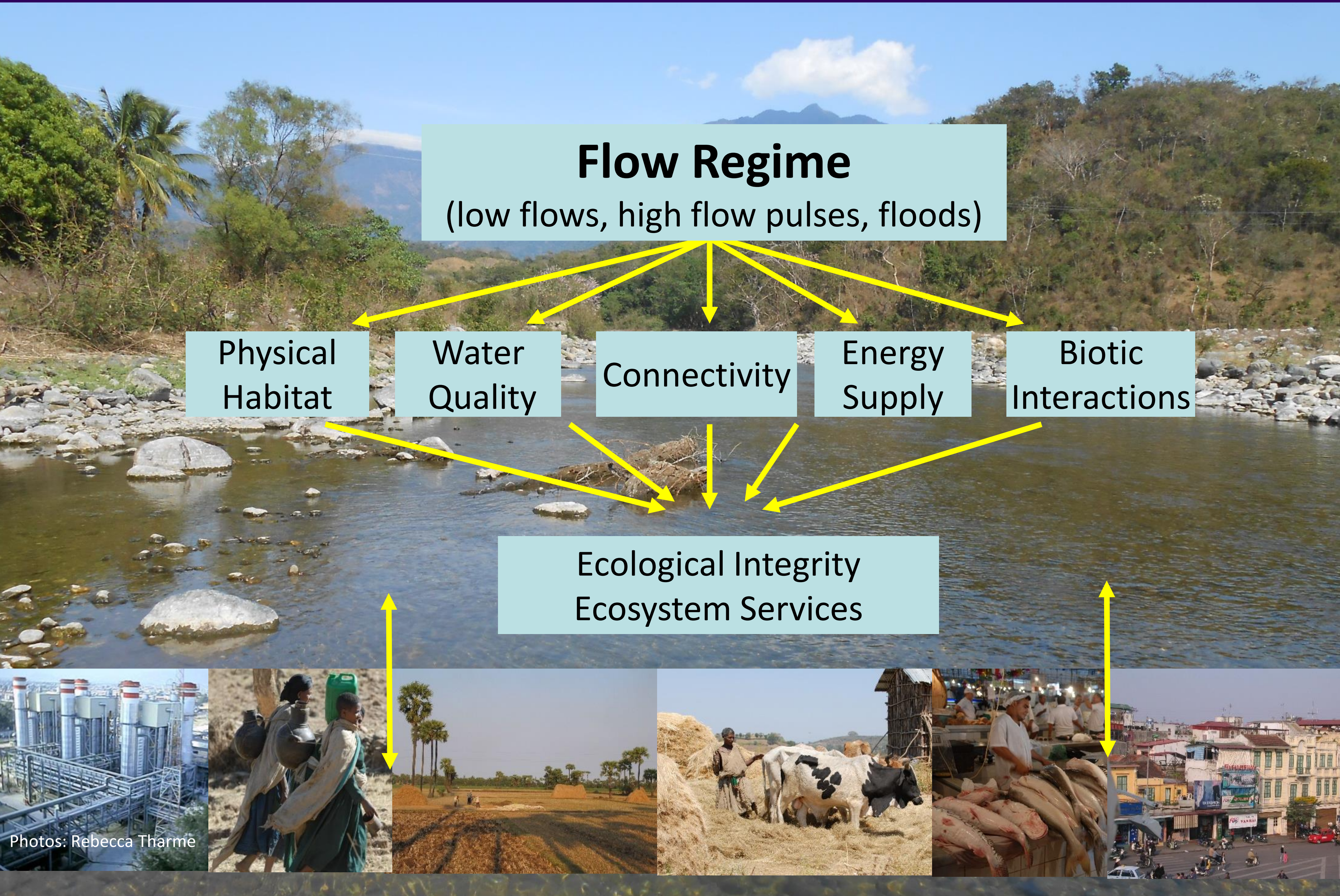
Instream Flow Council, FLOW 2018
Fort Collins, Colorado, 24-26 April 2018

Defining an Environmental Flow

"Environmental flows describe the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being".

(The Brisbane Declaration and Global Action Agenda on environmental flows 2018, in review)

Rivers are Social-Ecological Systems



Evolution of Environmental Flows

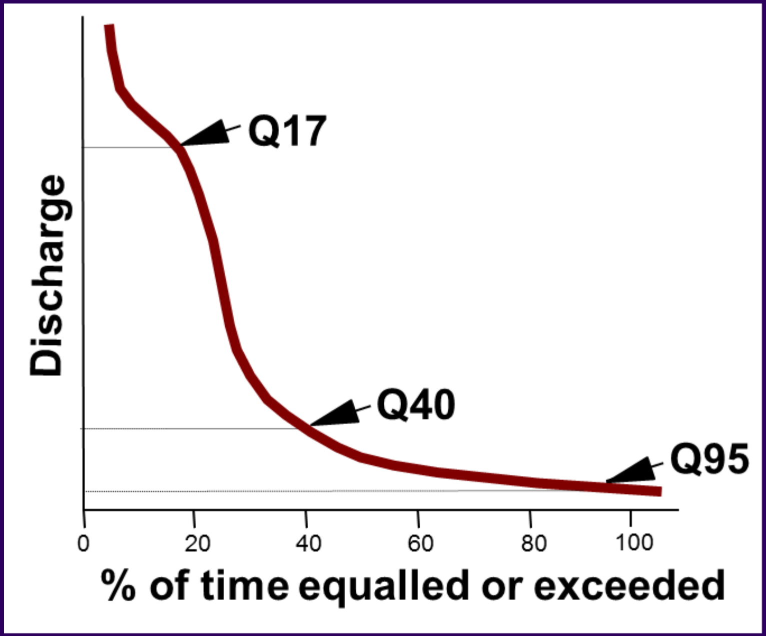
- Engineering Era (1940s-70s)
  - Water resource development for society
  - Minimum flows for pollution dilution
- Early Conservation Era (1970s-80s)
  - Minimum instream flows for important fish species
  - Simple flow-index methods and physical habitat methods
- Ecological Era (1990s-early 2000s)
  - Characterising flow regimes for entire ecosystems
  - Holistic methods, some with social factors
  - Data poor contexts
- Social-ecological Era (2000s-today)
  - Integrated values of people and nature
  - Scaling up to basins and regions
  - Water (re)allocation mechanisms
  - Designer flows for multiple benefits in novel systems
  - Climate adaptation and uncertainty

Photos: Rebecca Tharme

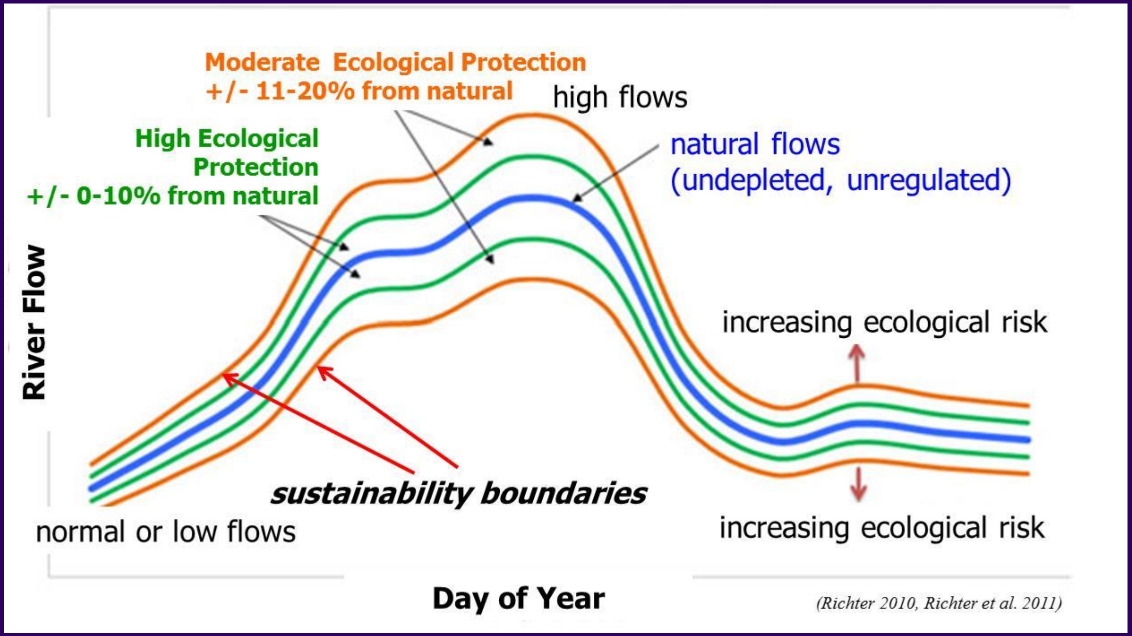
Hydrology-based Methodologies
Simple, rapid, low-confidence planning level

Low flow indices as minimum flows

e.g. 10% AAF, 7Q10, Q_{95}, Q_{min}

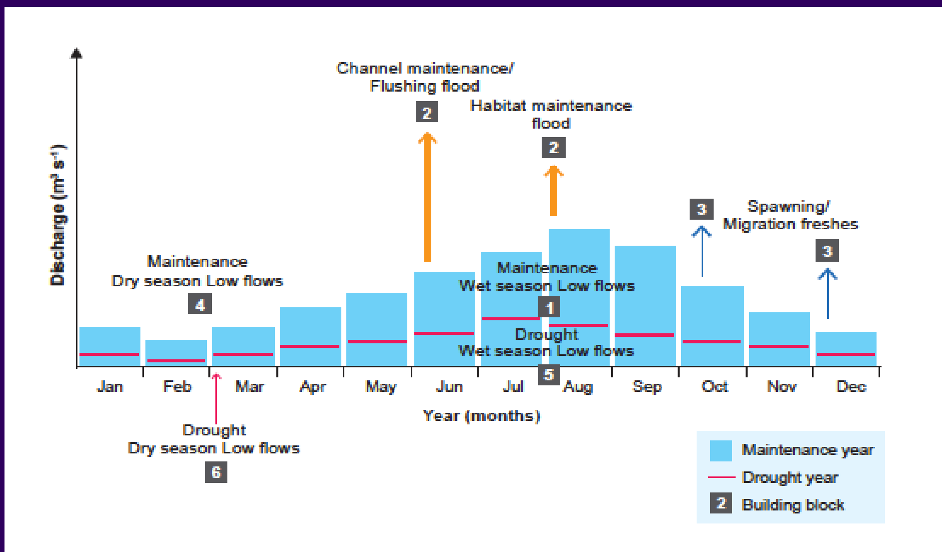


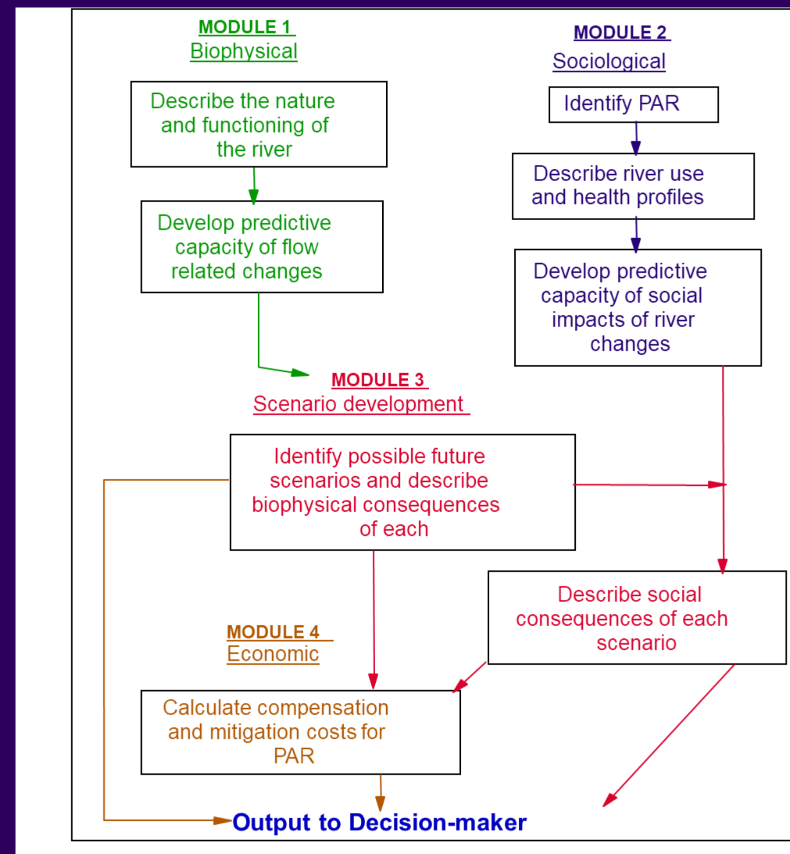
Precautionary risk based presumptive standards for ecological protection

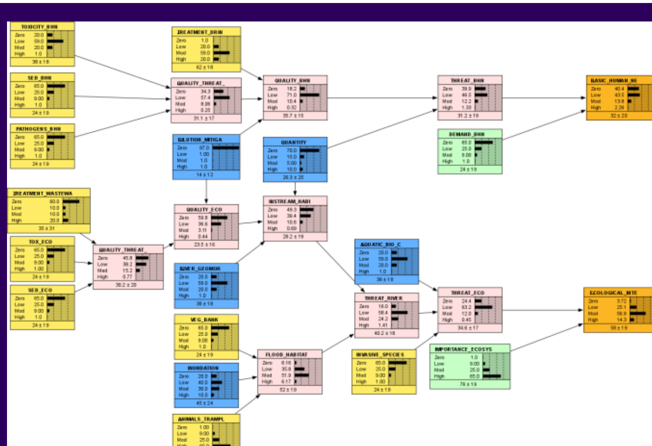


Holistic Methodologies

Comprehensive, resource intensive, moderate to high confidence, interdisciplinary, address whole ecosystem

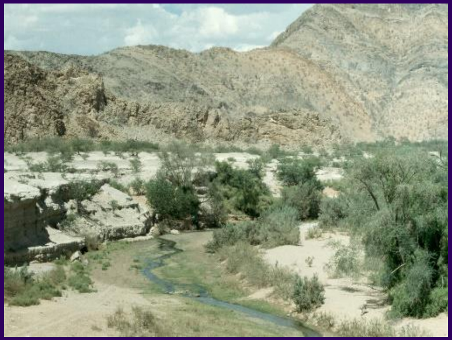






e.g. DRIFT, BBM, Probflo
ELOHA

Drought Considerations and Environmental Flows



Drought impacts on river ecosystems are an active research area

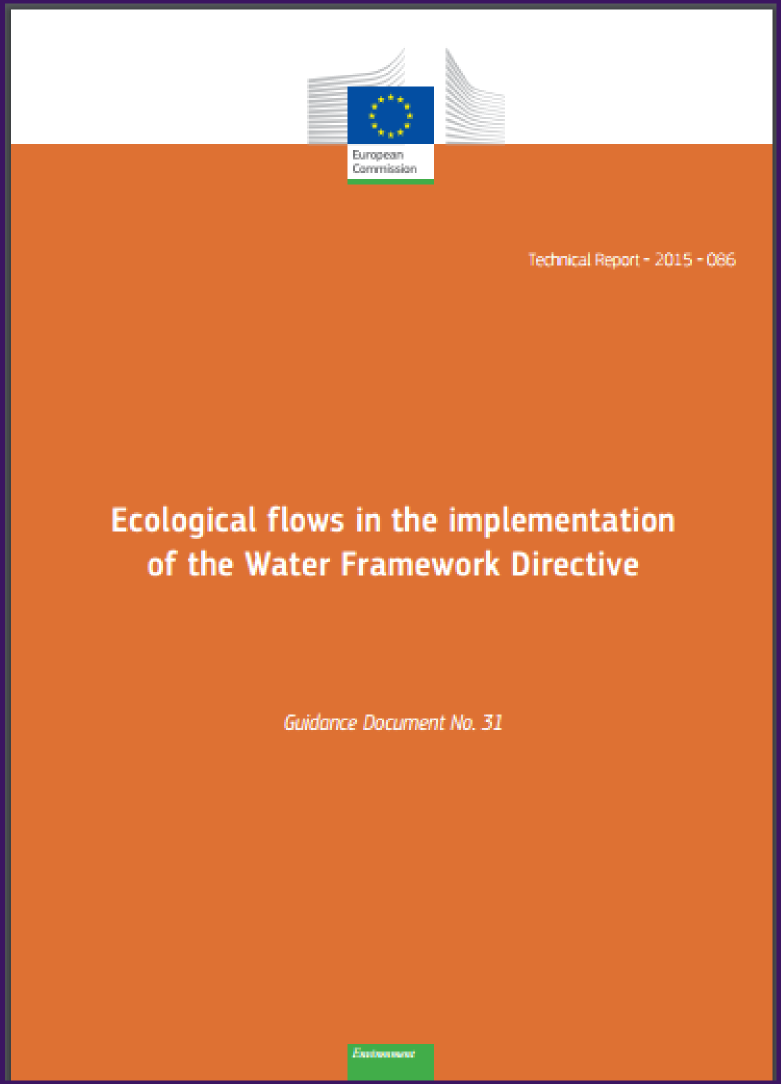
- Alternate views on ecosystem vulnerability - more vulnerable during droughts than at other times and so need highest protection vs. ecosystem is under stress from drought already so further flow reduction might not incur much more harm
- Ecosystem recovery is a central issue - findings suggest extending water abstraction restrictions after a drought has ended, to allow ecosystem to recover
- Importance of sequencing of wet and dry spells preceding and during major drought events in influencing ecological outcomes
- Roles and significance of low flow refugia and system connectivity

Water Policy and Practice in Georgia

Alignment with EU Water Framework Directive

"The Water Framework Directive, as well as the Birds and Habitats Directives, set binding objectives on protection and conservation of water-dependent ecosystems. **These objectives can only be reached if supporting flow regimes are guaranteed.**"

CIS Guidance Document No. 31 (2015)



Environmental Flow Policy Reform in Georgia

- Historic use of Soviet Era ‘sanitary flow’ of 10% of Mean Annual Runoff as eflow
- New legislation and permit procedures incl. for hydropower
- New national holistic methodology includes social component
  (iconic features e.g. waterfalls, economic uses e.g. rafting)
- Present guidance limited for drought

Photos: UNESCO-IHE

Proposed New Environmental Flow Methodology
Basic Flow Regime Components

Component 1 | Component 2 | Component 3

Survival Flow + Low Flow Periods + High Flow Events ⇒ Environmental Flow Regime

Social requirements

Ecological requirements

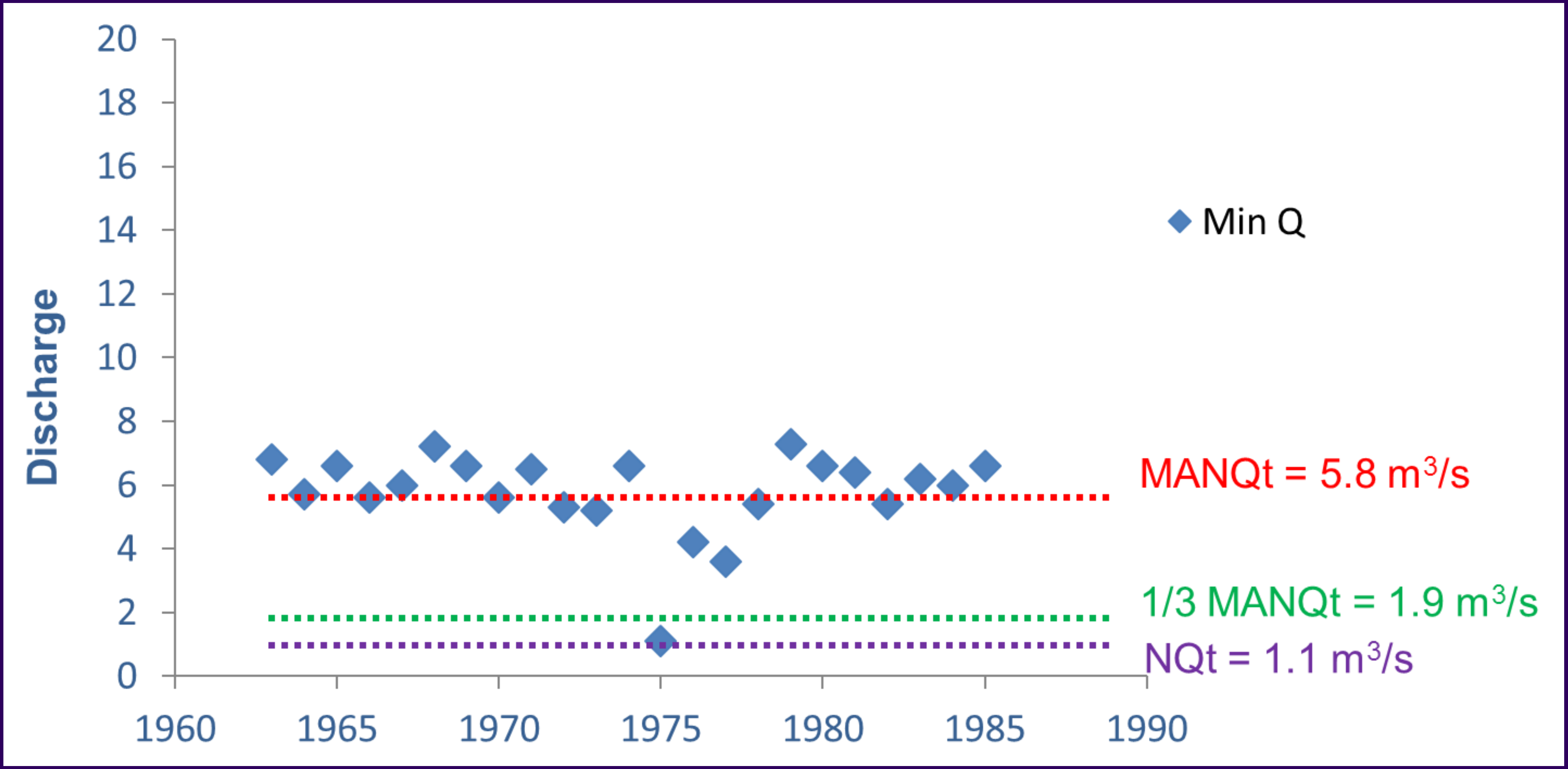
USAID FROM THE AMERICAN PEOPLE

Governing for Growth in Georgia

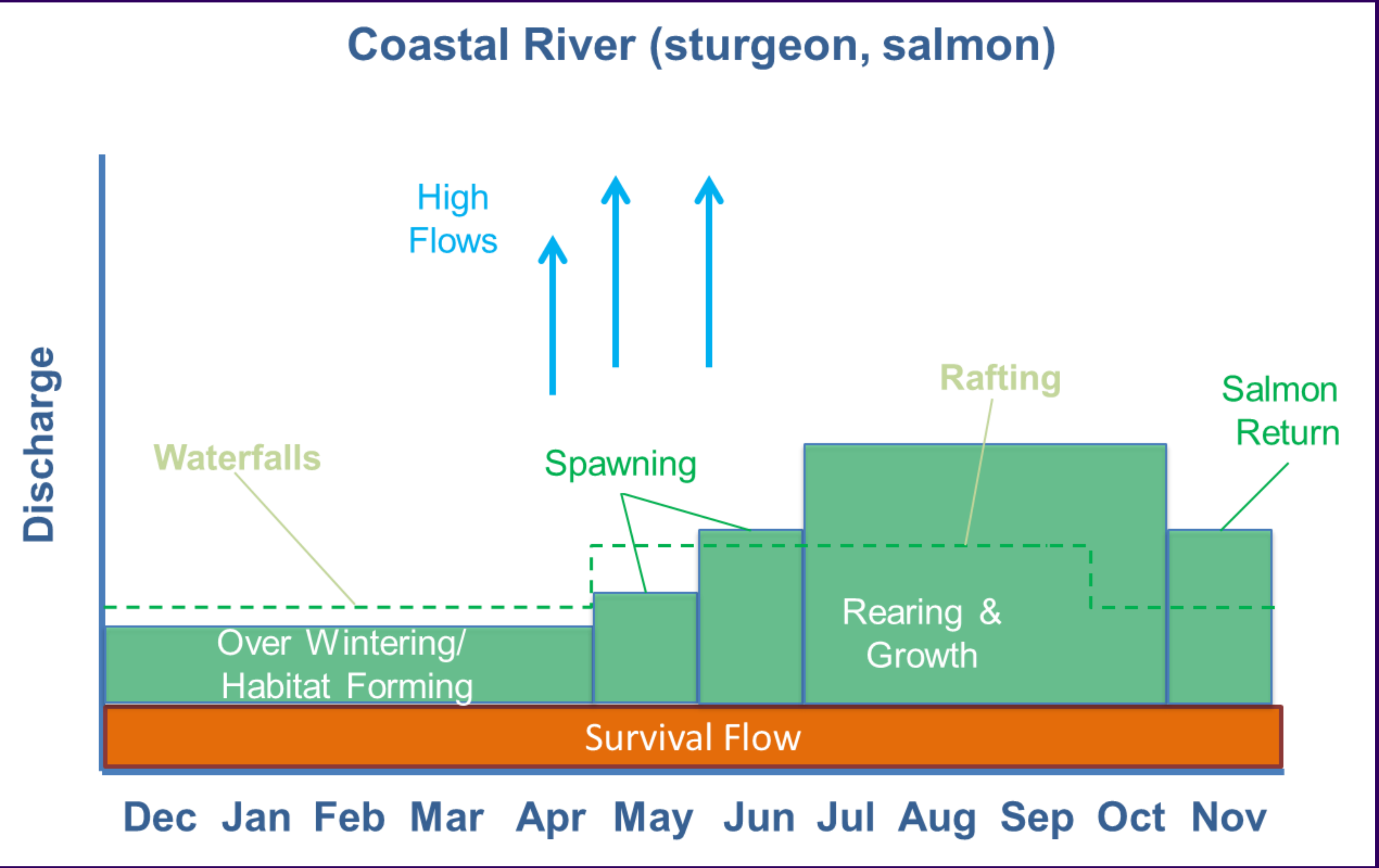
(USAID/G4G 2017)

Minimum Flow Rule as Basis of Survival Flow

Survival flow – The critical, extreme low flow recommended
during a designated drought period: exceeds natural lowest daily Qmin, accounts for at least a third to a half of natural mean annual minimum Q



Environmental Flow Regime of Ecologically and Socially Important Flow Events



Water Resources Management in Tanzania

National Water Policy 2002

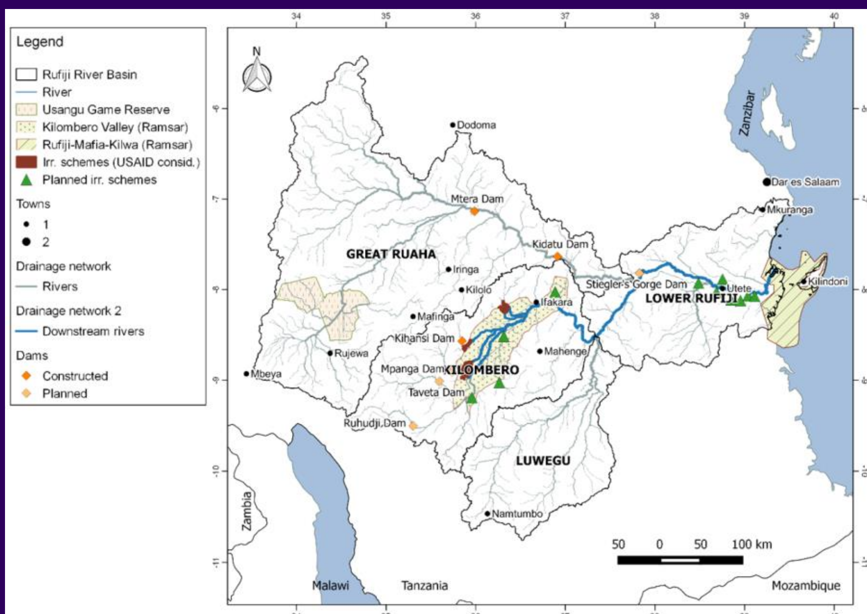
“water for basic human needs will receive highest priority, water for the environment to protect the ecosystems that underpin our water resources will attain second priority and will be reserved”

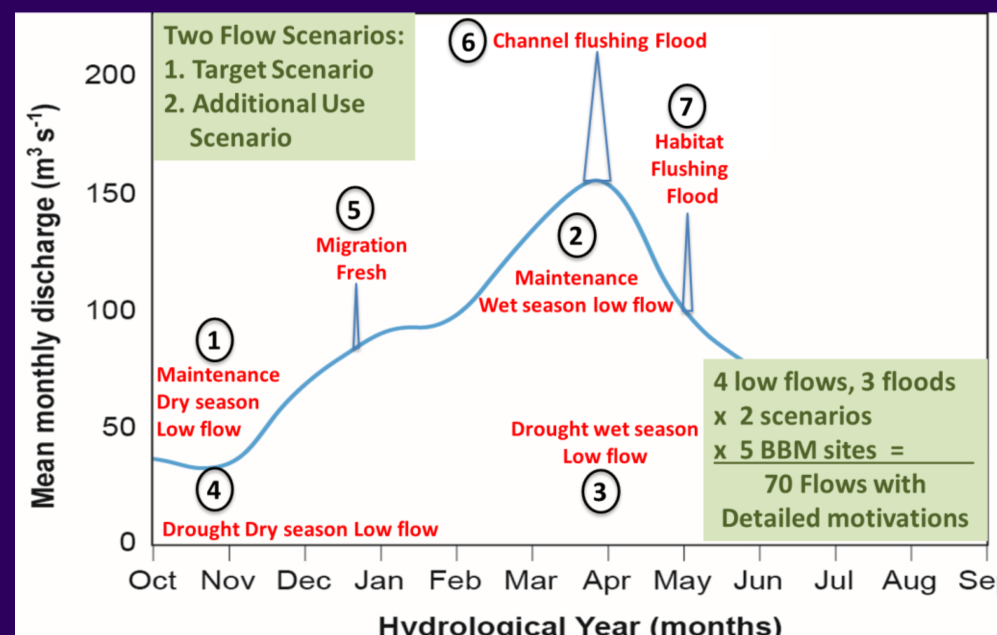
Water Resources Management Act (WRMA) No. 11 of 2009

“take into account and give effect to the requirements of the reserve”

Environmental Flow Assessment for the Rufiji Basin

To provide support for balanced use and protection of water resources by determining recommendations for the Reserve, *with special attention devoted to protecting ecological functions that also provide services to neighboring human communities*

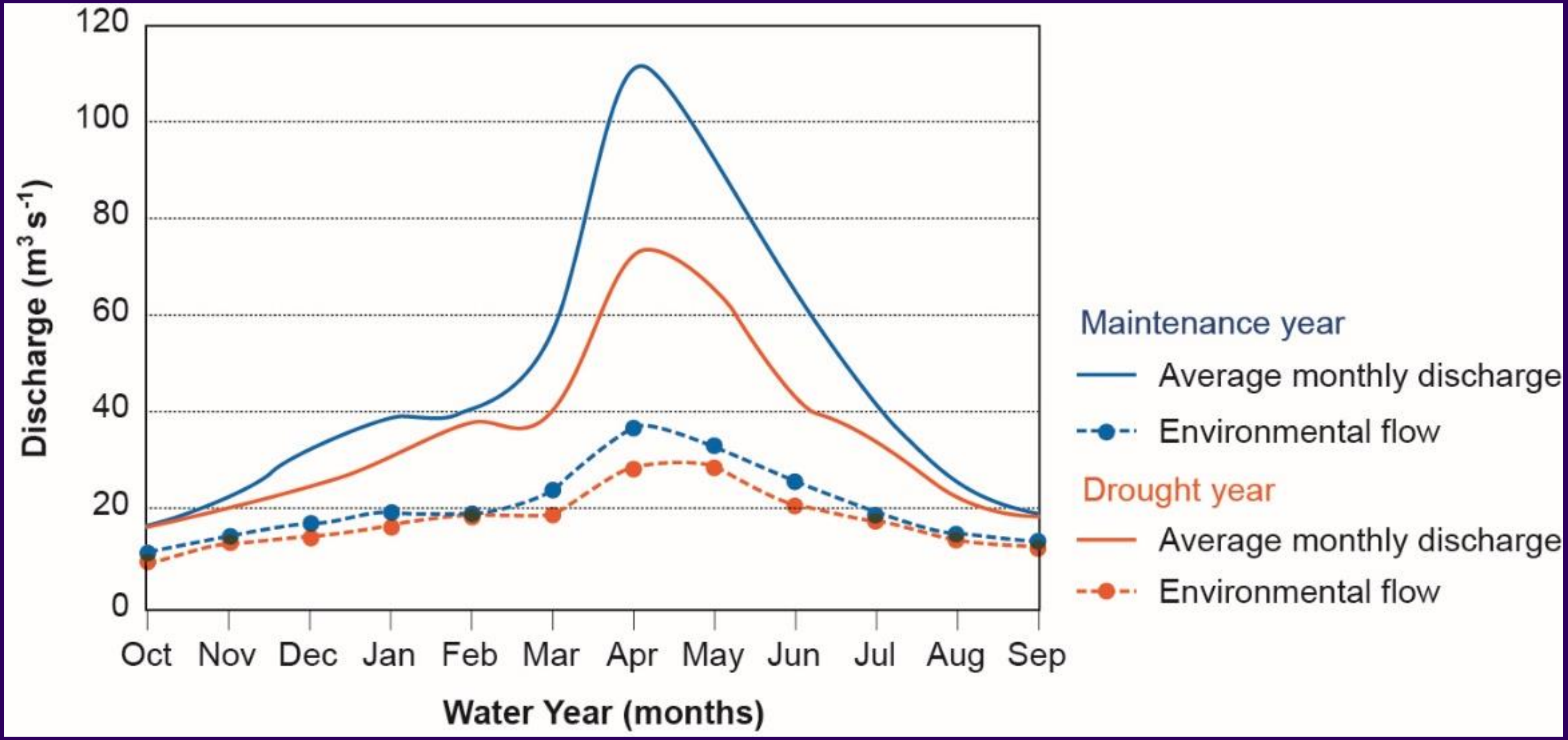




Rationale applied for Drought Year Environmental Flow Recommendations

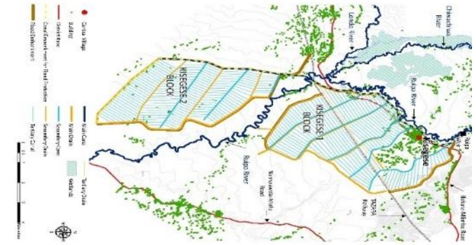
- Drought years determined based on driest years of record and considered to occur approx. 1 in every 5 years
- Definition of drought limited by short observed historical records at flow gauging stations (hence assumed high frequency of occurrence of such years)
- The drought year is equivalent to a significant drought event, in which the flows are insufficient to support all flow-related biophysical processes, e.g.
    - flow-sensitive species might miss a breeding season but would survive, likely in reduced numbers
    - typical flood events important as cues for migration or spawning might not occur
- Natural droughts (i.e. not due to human overexploitation of water resources) are viewed as ecologically necessary

Recommended Environmental Flow Regime Lwipa River, Kilombero Sub-basin

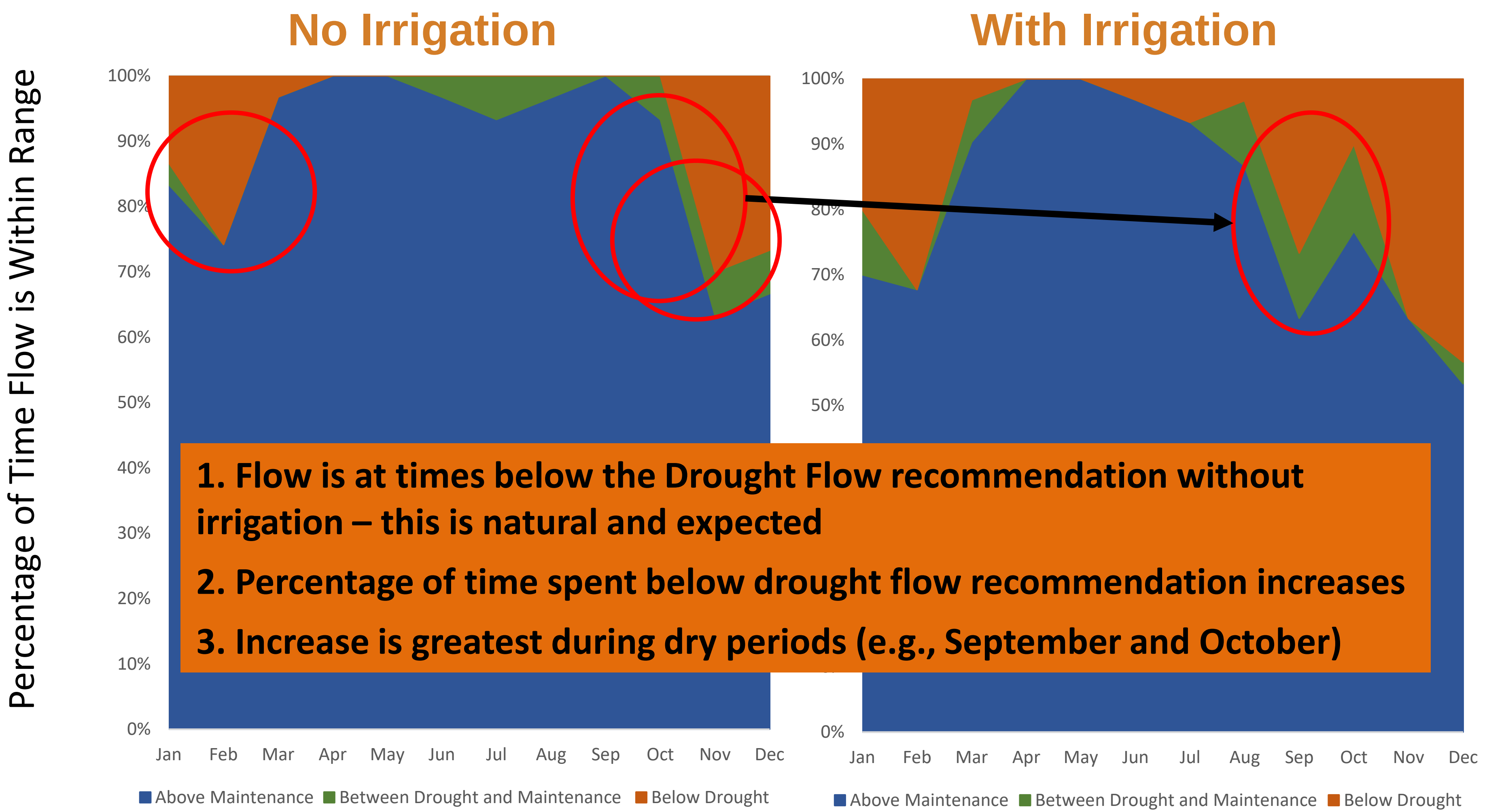


- Maintenance year: 2 small high flow events at wet season start, 2 large floods at peak of wet season (Mar, Apr), and 1 small flood late in wet season, yearly
- Drought year: 2 floods in peak wet season, both of smaller magnitude and shorter duration than in a normal year

Scenario of Irrigation Demands with Eflows for Lwipa River, for Kisegese Blocks 1 and 2



(CDM Smith 2016)

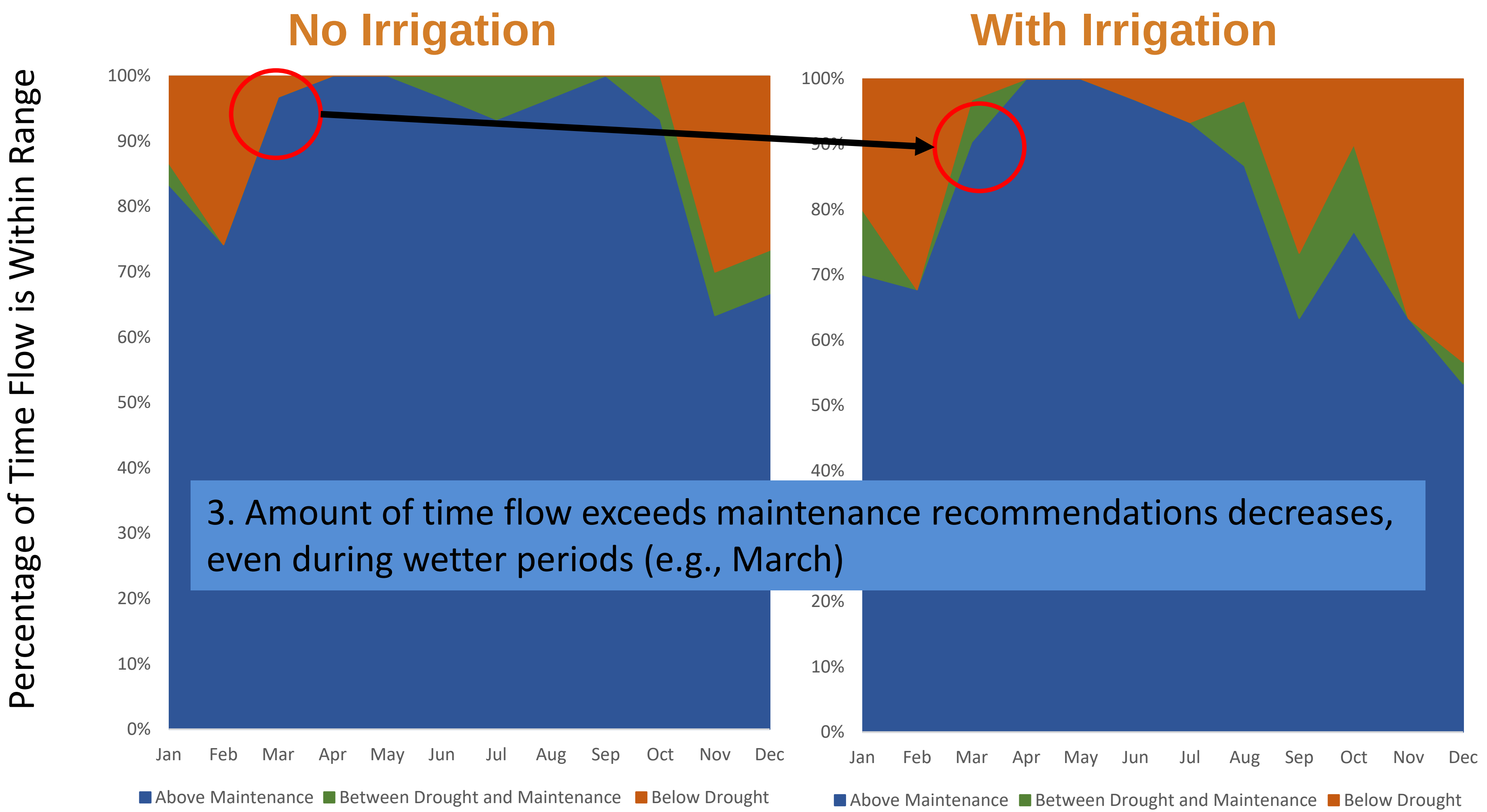


1. Flow is at times below the Drought Flow recommendation without irrigation – this is natural and expected

2. Percentage of time spent below drought flow recommendation increases

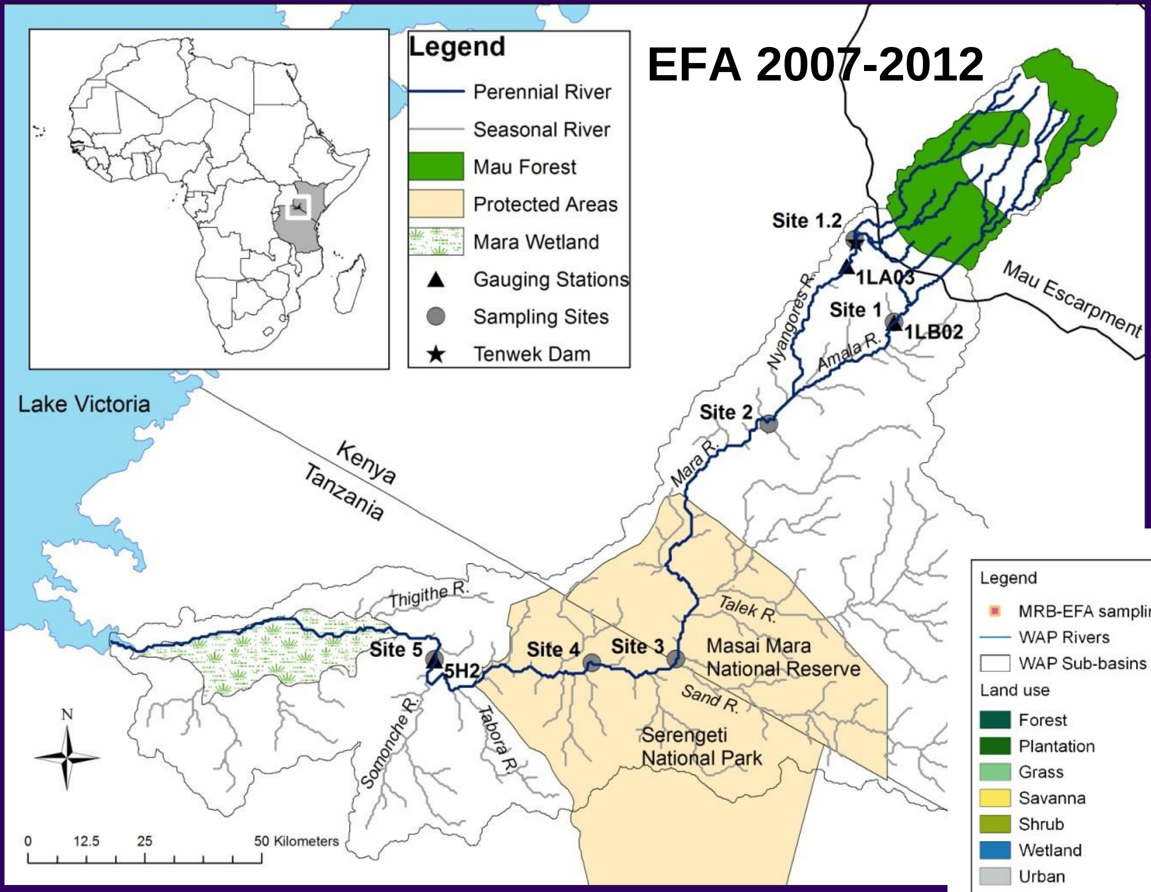
3. Increase is greatest during dry periods (e.g., September and October)

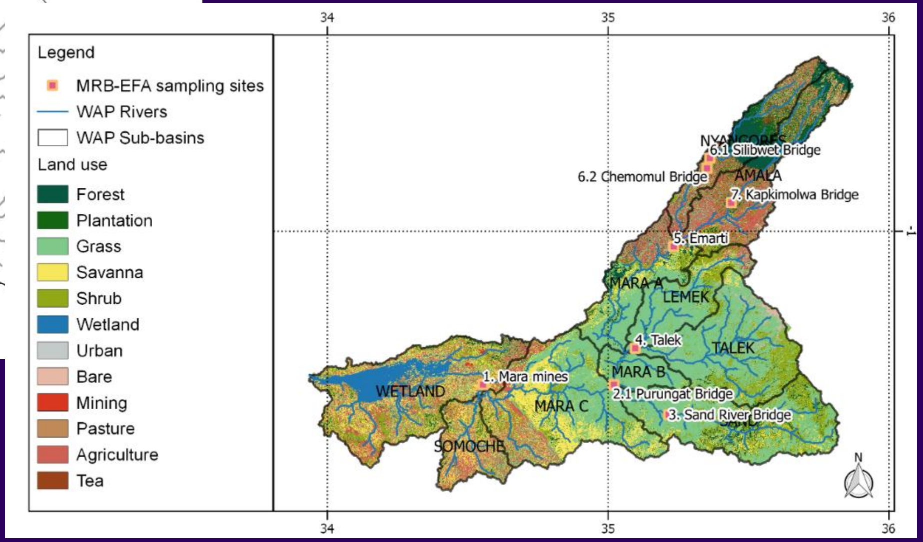
Scenario of Irrigation Demands with Eflows for Lwipa River, for Kisegese Blocks 1 and 2



3. Amount of time flow exceeds maintenance recommendations decreases, even during wetter periods (e.g., March)

Environmental Flow Assessments Transboundary Mara River Basin Kenya and Tanzania

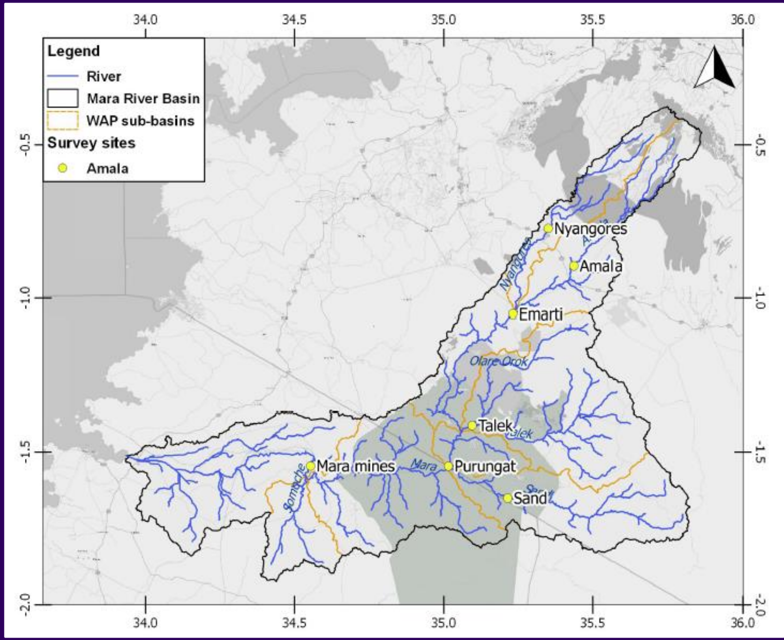




Water Allocation Planning for Mara River Basin Kenya

Water Resources Management Rules 2007

"establish the reserve based on water resource records and reserve water demand or ecological vulnerability, human vulnerability, local observations of historic drought flows, maintenance of perennial flows and consultations with WUAs"



The Water Act 2016 "prioritizes first the reserve i.e. quantity and quality required to satisfy basic human needs and protection of aquatic ecosystems. The Act is silent on the prioritization of the other uses of water and therefore Water Allocation Plans are seen as the best instruments to set out priorities on water allocation in case the water resource is not sufficient."

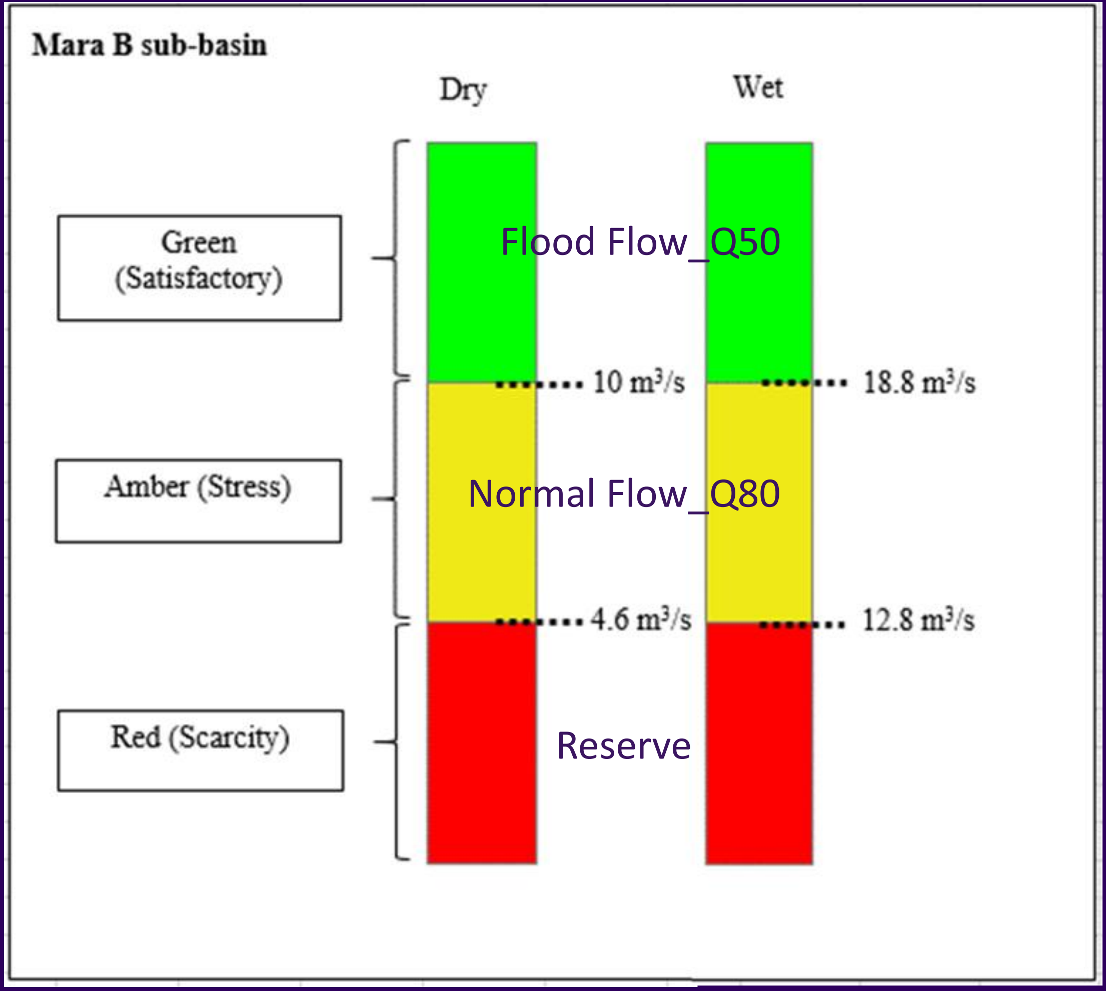
(Water Resources Authority, WAP, March 2018)

Water Allocation Plan for Mara River Basin

Restrictions on permitted abstractions to protect the reserve
during dry/drought periods, Lake Victoria South Catchment Management Strategy

Medium Flows

Low Flows



Water Resources Authority of Kenya Declares Low River Flows

The Water Resources Authority (WRA) has officially released a statement to all water users in the Upper Ewaso Ngiro Sub-Region declaring low river flows

The above image is the true representation of Nanyuki River – 15 January 2018

Gauge reading from Nanyuki River - 15th January 2018

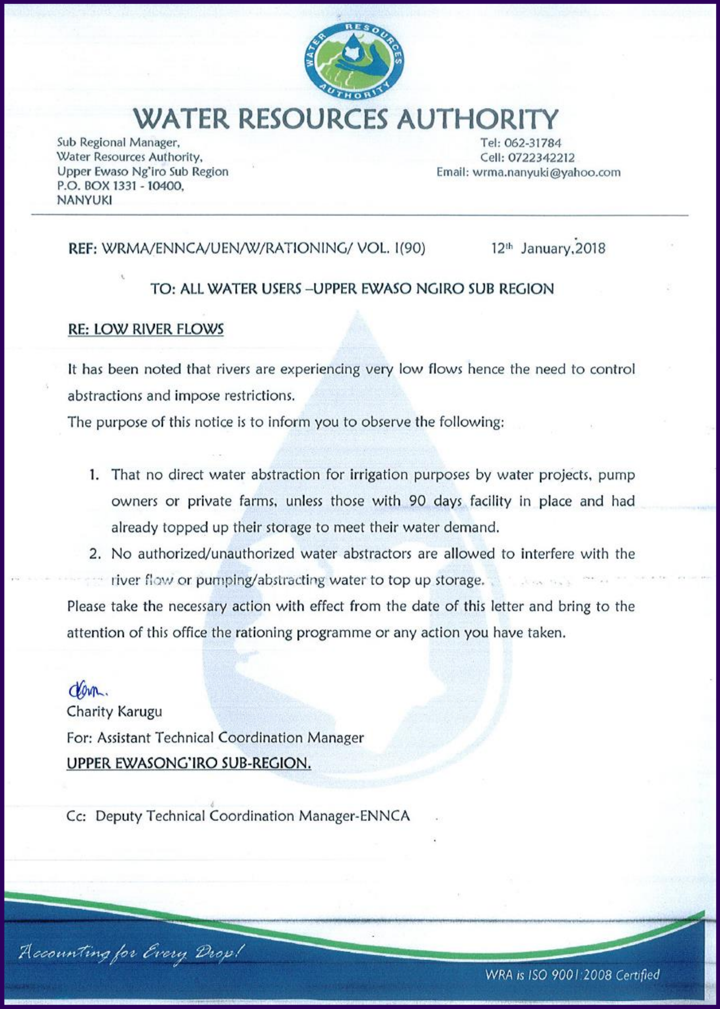
The purpose of the notice is for all water users to observe the following:

1. There will be no direct water abstraction for irrigation purposes by water projects, pump owners or private farms, unless those with 90 days facility in place and who had already topped up their storage to meet their water demand.

2. No authorised/unauthorised water abstractors are allowed to interfere with the river flow or pumping/abstracting water to top up storage

Hotline

WRA, WRUAs in the region and the MKEWP will set up a hotline number to report illegal water activities for action. This number will be made available to the public by 9th February 2018. Please note illegal water abstractors will be prosecuted!



WATER RESOURCES AUTHORITY

Sub Regional Manager,
Water Resources Authority,
Upper Ewaso Ng'iro Sub Region
P.O. BOX 1331 - 10400,
NANYUKI

Tel: 062-31784
Cell: 0722342212
Email: wrma.nanyuki@yahoo.com

REF: WRMA/ENNCA/UEN/W/RATIONING/ VOL. I(90) 12th January,2018

TO: ALL WATER USERS –UPPER EWASO NGIRO SUB REGION

RE: LOW RIVER FLOWS

It has been noted that rivers are experiencing very low flows hence the need to control abstractions and impose restrictions.

The purpose of this notice is to inform you to observe the following:

1. That no direct water abstraction for irrigation purposes by water projects, pump owners or private farms, unless those with 90 days facility in place and had already topped up their storage to meet their water demand.
2. No authorized/unauthorized water abstractors are allowed to interfere with the river flow or pumping/abstracting water to top up storage.

Please take the necessary action with effect from the date of this letter and bring to the attention of this office the rationing programme or any action you have taken.

Charity Karugu
For: Assistant Technical Coordination Manager
UPPER EWASONG'IRO SUB-REGION.

Cc: Deputy Technical Coordination Manager-ENNCA

Accounting for Every Drop!

WRA is ISO 9001:2008 Certified

Environmental Flow Standards for UK

- Look-up tables for environmental flows exist which extend down to low flows (e.g. Q95)
- No formal environmental flows allowance exists for drought situations

Table 4 Standards for UK river types/sub-types for achieving GES given as % allowable abstraction of natural flow (thresholds are for annual flow statistics).

Type or sub type	Season	Flow > Qn_{60}	Flow > Qn_{70}	Flow > Qn_{95}	Flow < Qn_{95}
A1	Apr.–Oct.	30	25	20	15
	Nov.–Mar.	35	30	25	20
A2 (ds), B1, B2, C1, D1	Apr.–Oct.	25	20	15	10
	Nov.–Mar.	30	25	20	15
A2 (hw), C2, D2	Apr.–Oct.	20	15	10	7.5
	Nov.–Mar.	25	20	15	10
Salmonid spawning & nursery areas (not Chalk rivers)	Jun.–Sep.	25	20	15	10
	Oct.–May	20	15	flow > Q_{80} 10	flow < Q_{80} 7.5

(Acreman et al. 2008)

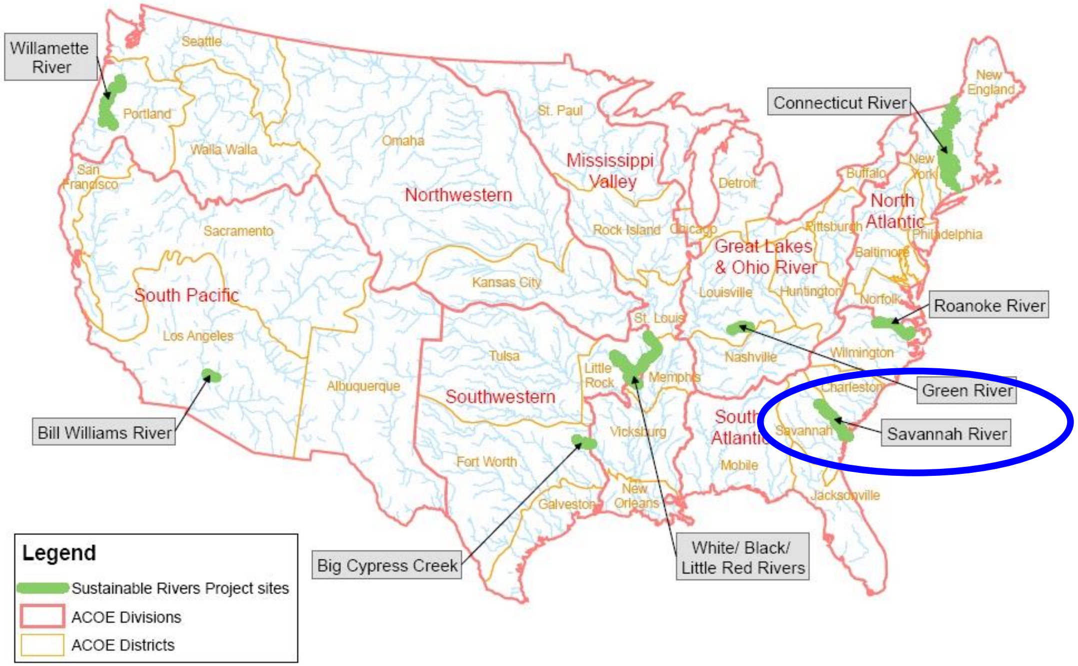
Drought Plans in UK

UK water companies (e.g. drinking water supply) are required to produce drought plans to use for periods when water is in short supply

- Could include abstraction beyond the environmental flow limits of selected rivers for short times during drought
- Plans are reviewed by statutory agencies to ensure that the most important nature sites (e.g. rivers/wetlands with important designation) are not significantly damaged
- Public health override to environmental flow allocations – people are not to be deprived of water (basic human needs)

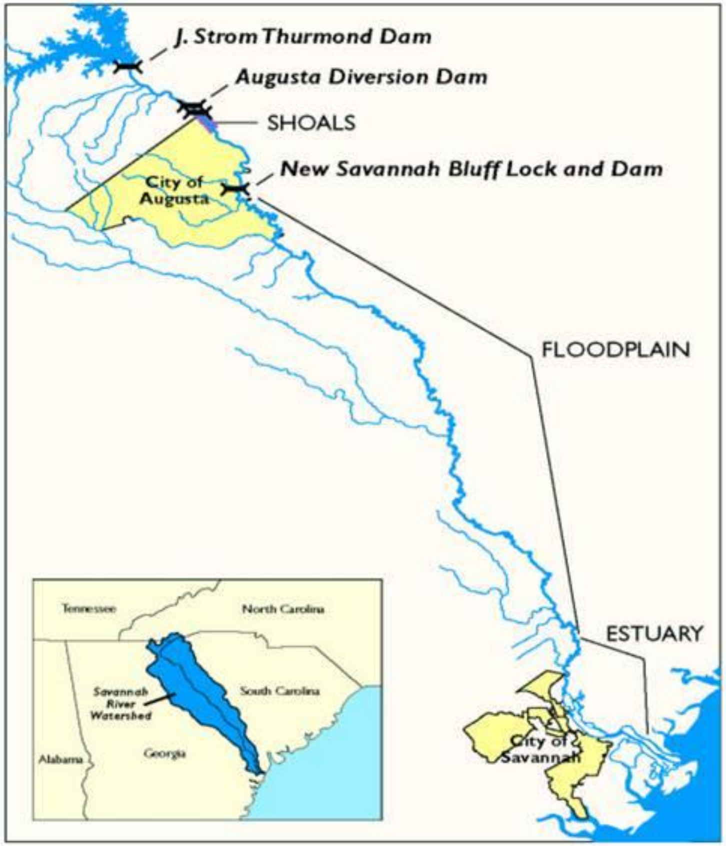
Sustainable Rivers Project

Current Sites



14 sites/60+ USACE dams

Lower Savannah River and Estuary Restoration



Environmental Flow Recommendations for Wet, Average and Dry Years Savannah River, USA (below Thurmond Dam)

Floods

50,000-70,000 cfs; 2 weeks, avg every 2 yrs
- Maintain channel habitats
- Create floodplain topographic relief
- Provide fish access to the floodplain
- control invasive species
- Maintain wetlands and fill oxbows and sloughs
- Enhance nutrient cycling & improve water clarity
- Disperse tree seeds

High Flow Pulses

>30,000 cfs; 5 pulses, >2 days with 2 events of 2 week duration (March and early April)

20,000-40,000 cfs; 2-3 days, 1/month
- Provide predator-free habitat for birds
- Disperse tree seeds
- Transport fish larvae
- Flush woody debris from floodplain to channel
- Floodplain access for fish
- Fish passage past NSBLD

<13,000 cfs; 3 successive years, every 10-20 years
- Floodplain tree recruitment

8,000-12,000 cfs;
- Exchange water with oxbows

Details:
20,000-40,000 cfs; 2-3 days, 1/month
Purposes:
- Provide predator-free habitat for birds
- Disperse tree seeds
- Transport fish larvae
- Flush woody debris from floodplain to channel
- Floodplain access for fish
- Fish passage past NSBLD

Low Flows

>8,000 cfs
- Larval drift for pelagic spawners

<5,000 cfs
- Adequate floodplain drainage
- Create shallow water habitat for small-bodied fish

3,000 cfs; 3 successive years every 10-20 years
- Floodplain tree recruitment

Key

Wet Year

Avg Year

Dry Year

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

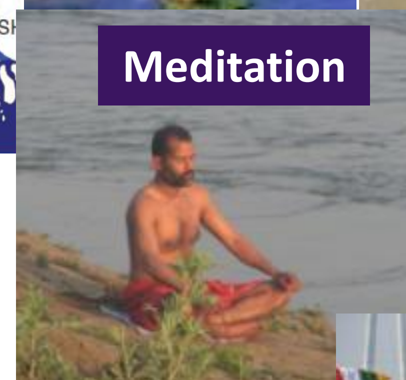
Prescription 2.0 Environmental Flow Recommendations for Drought Conditions in the Savannah River, USA

- Driven by:
  - New flow-focused research including specific to drought
  - Recurrence of severe drought periods, a condition the original Prescription did not address
  - Funding for, and a desire by the USACE Savannah District and partners to develop a new Savannah River Basin Drought Control Plan (SRBDCP) for Savannah River facilities
- Six alternatives developed for analysis, including a Drought Ecosystem Flow Alternative, developed using a workshop process similar to original Prescription
- Results to be used to identify a preferred SRBDCP alternative for selection as new basis for drought operations
- Drought state prescription to apply when inflows are less than the 10th percentile of 28-day moving average flow at specific gauge

Environmental Flow Recommendations for Drought Conditions in the Savannah River

	Flow Type	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Drought Year – Shoals	Min Base Flow (4 in 10 years)	1500	3300			2500	1500						
	Min Base Flow; Thurmond ≥3600	1500	2000			1500							
	Min Base Flow; Thurmond ≤3600	1500	1800			1500							
	Max Base Flow					20,000 cfs max; 2-3d							
	Ramping / Variation Rate (+/- cfs)	1000	500			1000							
	Pulse Flows	No recommendation											
	Flood Flows	No recommendation											
		Base flows are tied to drought years. So, 4 in 10 means 4 in 10 *drought* years. The remaining 6 of 10 are tied directly to the Augusta FERC settlement flows. All flows reflect what is actually *in the shoals*. Ramping rates are recommendations of the Shoals group (+/-1000 cfs at all times) further conditioned by Floodplain group recommendations to minimize subdaily variation to +/-500 cfs during shortnose sturgeon and robust redhorse spawning.											
Drought Year – Floodplain	Min Base Flow			≤4000 (may include periods as low as 2000 cfs)									
	Max Base Flow			10000									
	Ramping / Variation Rate (+/- cfs)		500										
	Pulse Flows	4000-6000; 1d / mo.				4000-6000; 1d / mo.							
	Flood Flows	No floods in dought years											
		Justification driven by floodplain tree establishment - requirement for dry period for seedlings. Min base flow is based purely on floodplain reach ecology; Group recognizes that harbor DO constraints may inhibit ability to drop below 3000 cfs. One-day pulses of 4-6000 cfs reconnect and recharge DO in 90% of cutoff channel habitats; match timing to high tide when possible to retard salinity intrusion in harbor.											
Drought Year – Estuary	Min Base Flow	4000		5000									4000
	Max Base Flow	None											
	Ramping / Variation Rate (+/- cfs)	No estuary recommendation -- carry over from shoals and floodplain											
	Pulse Flows			(1) 12000 cfs; 14 d.									
	Flood Flows	No floods in drought years											
		Flows at Clyo. Pulse flow for freshwater flow input to freshwater marshes; preferably early growing season to retard salt-tolerant species, and to coincide with striped bass spawning. Monitoring the relationship between flows and spawning success for striped bass could refine the timing of this pulse.											

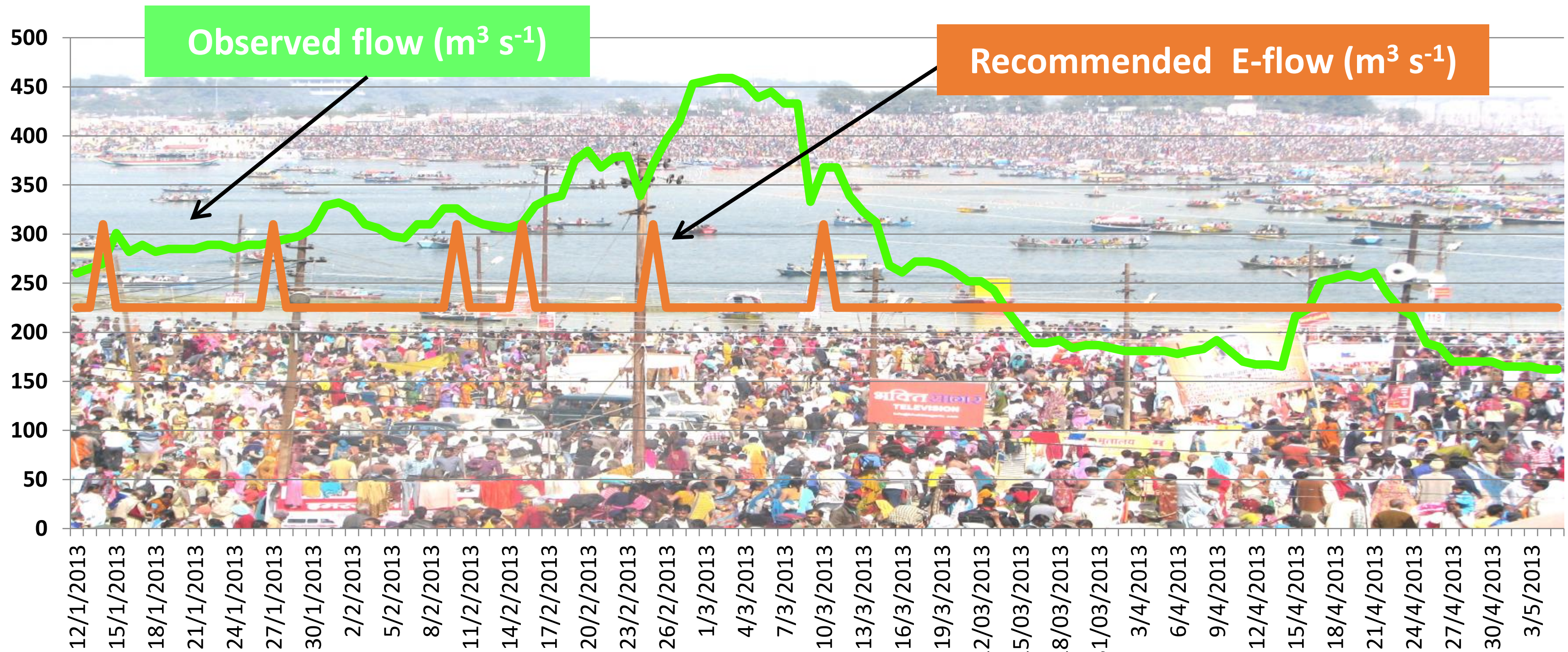
Upper Ganga River India E-Flows Assessment



Building Block Methodology (BBM) adapted to include sociocultural flow requirements for cultural tourists and local people, for performing rituals

- **Meditation (natural places, adequate levels and quality)**
- **Bathing (waist deep)**
- ***Aarti (*morning and evening worship)**
- ***Achmaan (*before or during other rituals, quality of water to mouth)**
- ***Kaavad* (annual, Mid-Jul to Mid-Aug) and Ganga water for homes**
- **Immersing ashes of deceased**

Monitoring Environmental Flows for Kumbh 2013 at Triveni Sangam, Ganges Basin, India

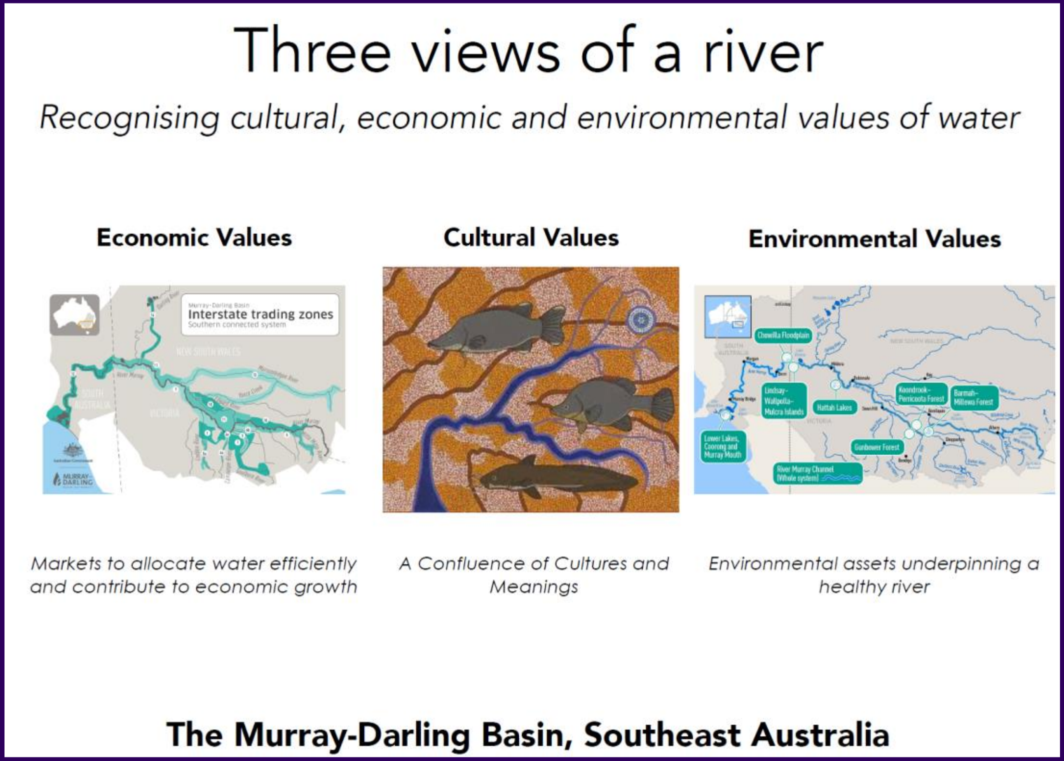


Concluding Remarks

- Regular implementation of ecologically appropriate flow regimes promotes heathier, more resilient systems that are arguably better able to persist in times of drought or scarcity

- Defining drought, determining specific eflows recommendations for such conditions, and establishing an adaptive, auditable plan for their implementation aligned as far as possible with policy, institutional arrangements, and management procedures are important early steps

- Both environmental and socioeconomic values, objectives and monitoring endpoints need to be considered



Source: Dustin Garrick 2017

Thanks

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Riverfutures