

# Trade-offs between different river reaches

Mainstreaming of Environmental Flows into Integrated Water  
Resources Management  
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# Trade-offs between different river reaches

- A simple flow routing tool
  - The “Configuration Tool”; The “Balancing Tool”
  - The Tool
- Used as part of the Classification and Resource Quality Objectives processes for the Breede, Berg and Gouritz Water Management Areas

# Main principles and aims

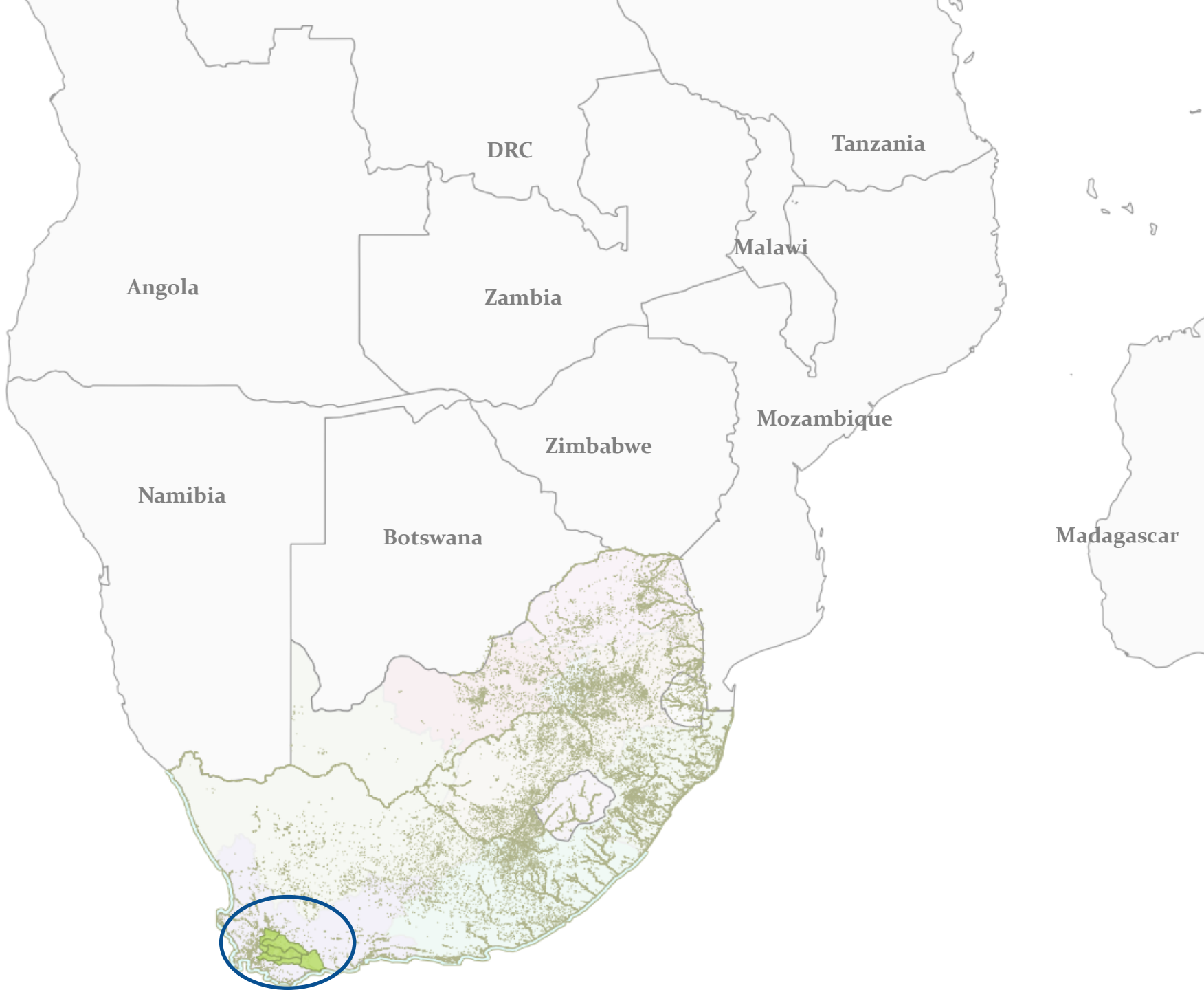
- If flows are changed on one part of the river, downstream reaches will also be affected (possibly all the way to the estuary)
- Changes in flow can cause changes in ecological condition
- Aim:
  - Change flows and “route” them, so as to...
  - ...determine the effects of (flow) scenarios on resulting ecological conditions at each “node”
    - In a relatively simple way without needing to run a hydrological model for each test

# Inputs

- At each node:
  - Natural average monthly flow
  - Current average monthly flow
  - EFlow average monthly flows (for B, C, D, etc.) – based on EFlow studies and extrapolated to other sites.
  - Scenarios' average monthly flows (e.g. future growth)
  - For each node & scenario: 12 numbers + total for node
- Current ecological condition (EC) (“PES”)



# Example: Breede basin Western Cape





SALDANHA

MALMESBURY

WORCESTER

ROBERTSON

CAPE TOWN

STELLENBOSCH

SWELLENDAM

HERMANUS

BREDASDORP

*Breede*

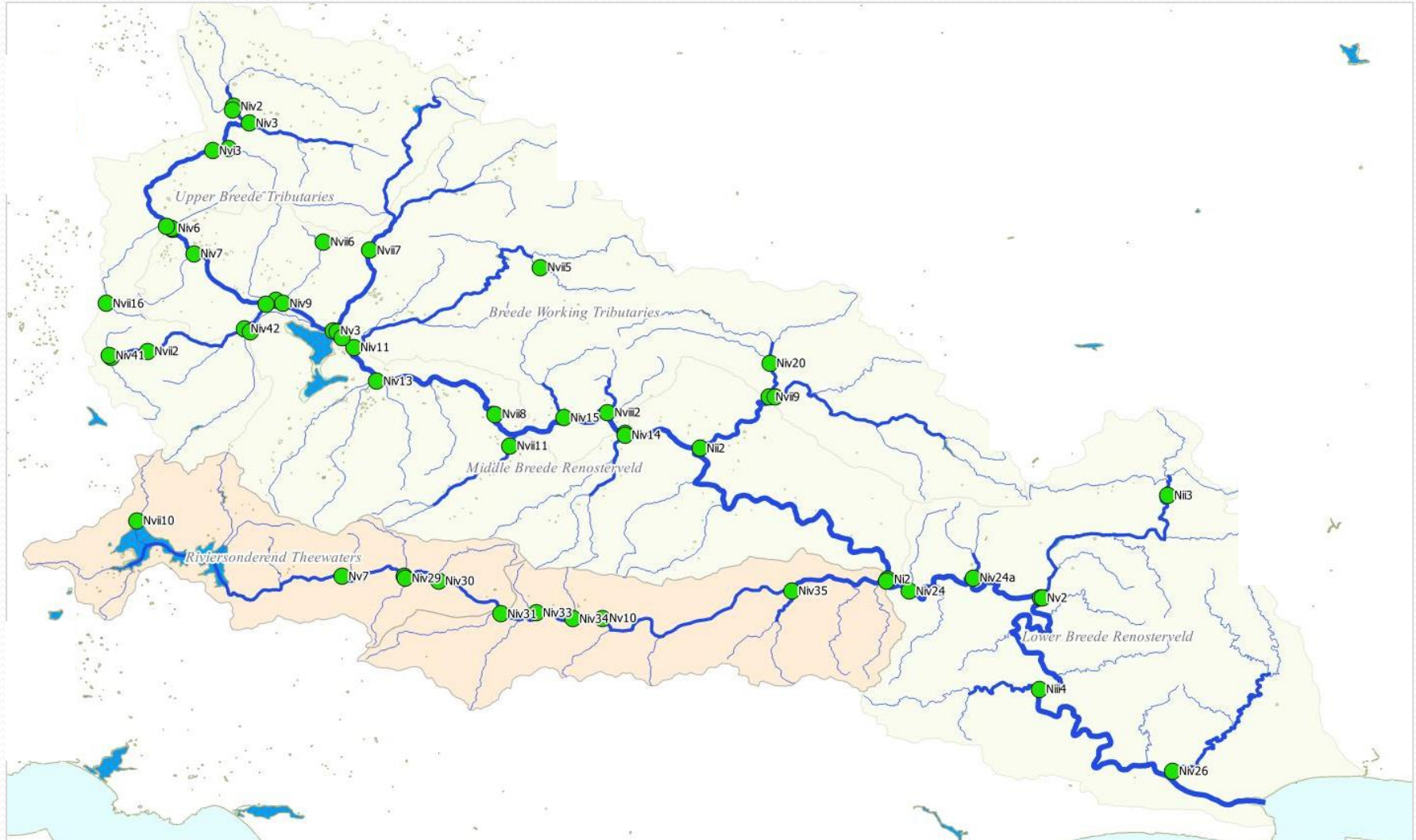
*Riviersonderend*

# Example: Breede basin Western Cape

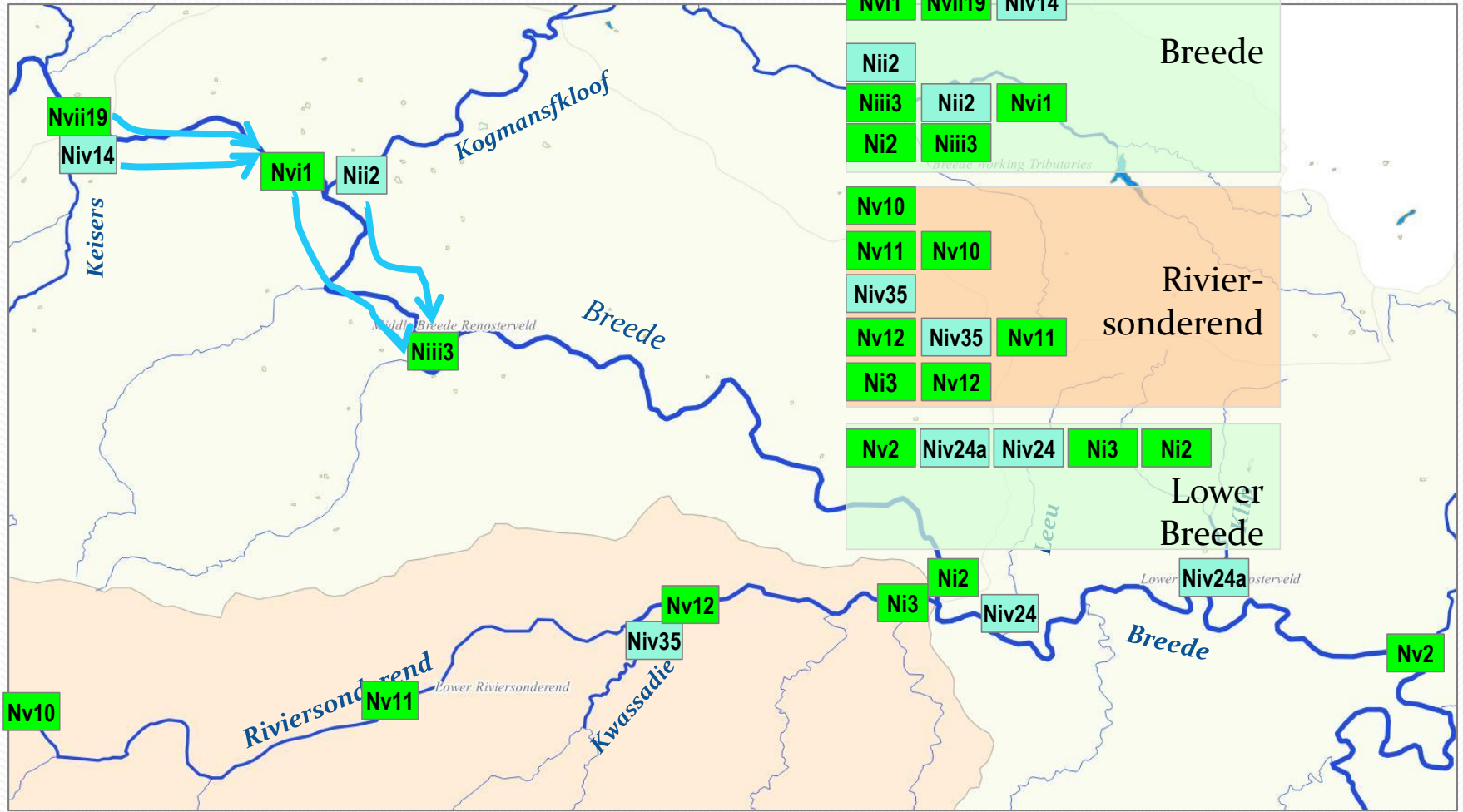
- Two main rivers:
  - Breede (“wide river”)
  - Riviersonderend (“river without end”)
- Several dams, including Theewaterskloof on Riviersonderend: largest dam supplying Cape Town
- Farming along much of their lengths
- Some “pristine” tributaries
- Estuary conservation importance: ranked 18 out of 250



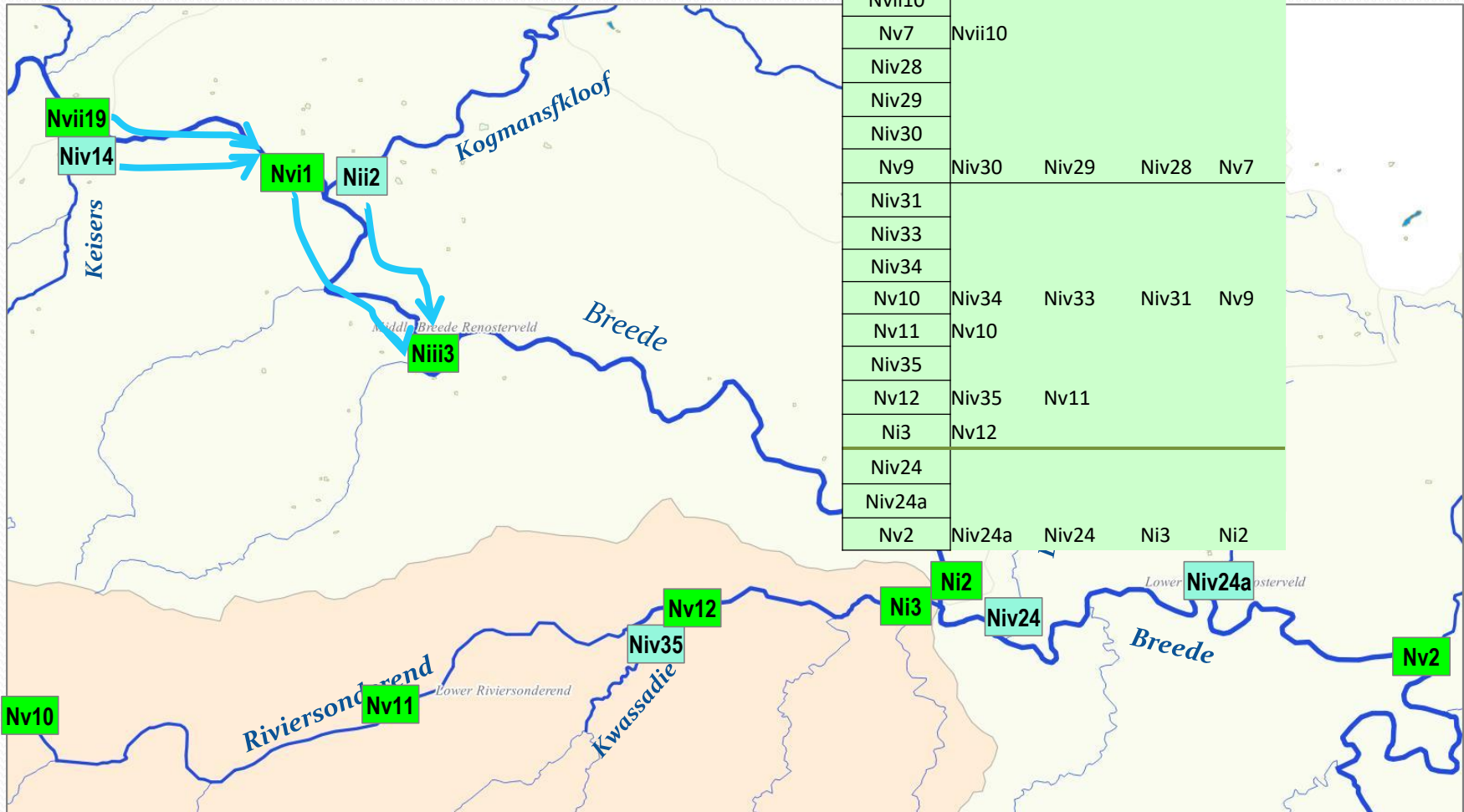
# Setup of “the tool” (1)



# Setup (2)



# Setup (3)



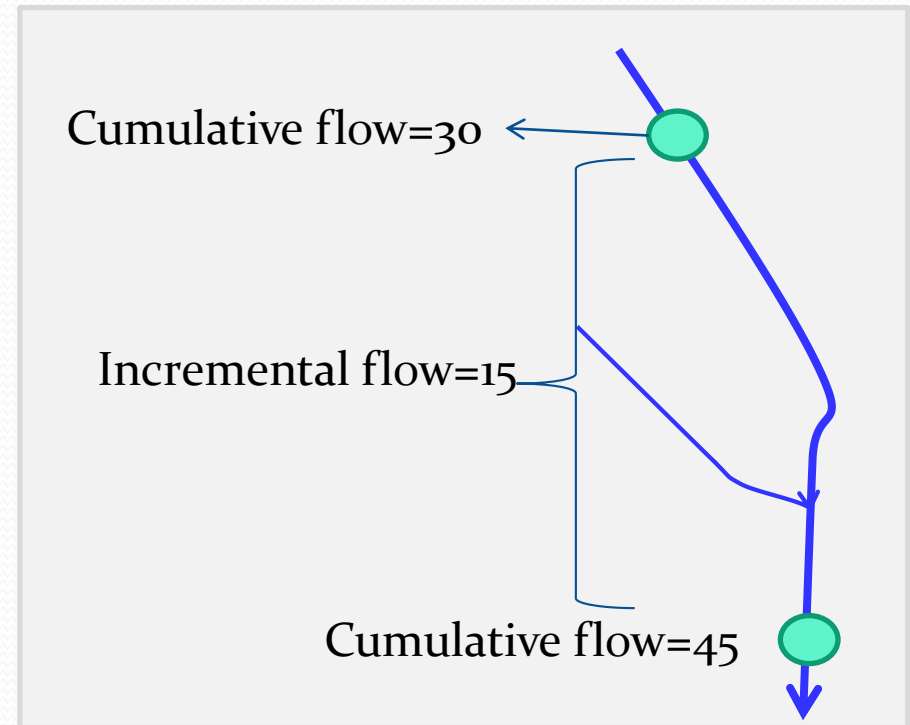
Node	"Feeders"			
Nvii9	Niv20			
Nvi1	Nvii19	Niv14		
Nii2	Nvii9	Niv18		
Niii3	Nii2	Nvi1		
Ni2	Niii3			
Nvii10	Nvii10			
Nv7	Nvii10			
Niv28				
Niv29				
Niv30				
Nv9	Niv30	Niv29	Niv28	Nv7
Niv31				
Niv33				
Niv34				
Nv10	Niv34	Niv33	Niv31	Nv9
Nv11	Nv10			
Niv35				
Nv12	Niv35	Nv11		
Ni3	Nv12			
Niv24				
Niv24a				
Nv2	Niv24a	Niv24	Ni3	Ni2

# Inputs

- At each node:
  - Natural average monthly flow
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  - For each node & scenario: 12 numbers + total for node
- Current ecological condition (EC) (“PES”)

# Inputs(2)

- Cumulative flow:
  - The flow in the river at any point: accumulated from upstream and the immediate catchment
- Incremental flow:
  - The flow added between two points along the river
  - i.e. from the inbetween surrounding catchment runoff and tributaries
- At each node:
  - Both incremental and cumulative flow



# Ecological category & Flow category

- Ecological condition / category (EC) not a result of flow alone
  - e.g. A river reach might have 80% of natural mean annual runoff (nMAR), and in the correct seasons, but current EC (or PES) could be a D.
- Therefore we have used the both EC and a “flow category” (FC)
- Flow category based on % of natural runoff

# Ecological categories

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

# Example of EC and FC (Breede site: EWR1)

	B	DJ	J	DB	K	L	DF	AS	AT
1	Nodes				<b>Current</b>				
2	Site								
3			EWR	REC	Ecological Category	Flow Category	Current Annual %nMAR	Seasonal flow % Nat	
4	1	River						WET	DRY
36	Niv3	Titus			C	B	82.0	96.3	0.2
37	Niv1	Koekedou			D	A/B	96.3	104.2	35.4
38	Niv2	Dwars			C	B	62.5	64.2	59.7
39	nvi4	Breede			C	B	70.4	76.6	33.2
40	Niv4	Witels			A	A	100.0	100.0	100.0
41	Nvi3	Breede			C	B	75.1	83.6	29.9
42	Nvii16	Witte			A	A/B	92.0	92.1	89.7
43	Niv5	Witte			A	A/B	88.4	90.4	72.6
44	Niv6	wabooms			D	C	64.1	91.9	0.0
45	Nviii1	Breede	EWR1	D	D/E	B	77.2	87.0	21.9

Non-flow related issues:

- Presence of alien fish and vegetation species;
- Mechanical changes to floodplain and river channel;
- Irrigation return flows and sewage impacting water quality.

Flow related:

- Abstraction resulting in low flows in summer.





# Examples in the tool

# Tasks

- Upper Breede:
  - Manipulate the flows on the mainstem and tributaries upstream, so as to try to achieve a D Ecological Category at EWR<sub>1</sub> (at node Nviii1)
  - Check the effects (if any) downstream all the way to the estuary.
- Middle Breede:
  - “simulate” additional abstraction for irrigation on the Holsloot tributary (at node Niv12)
  - Assess the effects (if any) downstream all the way to the estuary
- Riviersonderend:
  - “simulate” reduced releases from Theewaterskloof (at node Nv7) (e.g. because water pumped to Cape Town)
  - Assess the effects (if any) downstream all the way to the estuary
  - How much do flows have to change to reduce EC at the estuary?

