water & sanitation
Department: Water and Sanitation
REPUBLIC OF SOUTH AFRICA

The Determination of Water Resources Classes and Resource Quality Objectives in the Berg Catchment and Breede-Gouritz WMA

Evaluation of Scenarios Training

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Venue: DWS, Bellville

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Study Status

STEP 5-7

STEP 1: DELINEATE CATCHMENT & DESCRIBE STATUS QUO
Outcome: Integrated Units of Analysis & nodes
Complete

STEP 2: LINK ECONOMIC & SOCIAL VALUE
Outcome: How economic value & social wellbeing is influenced by ecosystem characteristics & use of water
Complete

STEP 3: QUANTIFY THE ECOLOGICAL WATER REQUIREMENTS AT EACH NODE
Outcome: Ecological Water Requirements
Complete

STEP 4: SET A BASELINE FOR ECOLOGICAL SUSTAINABILITY
Outcome: Ecologically Sustainable Base Configuration
Complete

STEP 5: EVALUATE SCENARIOS WITHIN INTEGRATED WATER RESOURCE MANAGEMENT PROCESS
Outcome: Identified and evaluated scenarios
Draft

STEP 6: EVALUATE SCENARIOS WITH STAKEHOLDERS
Outcome: Recommended scenario and DRAFT Water Resource Classes

STEP 7: GAZETTE WATER RESOURCE CLASS CONFIGURATIONS
Outcome: Gazetted Water Resource Classes

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Classification and RQOs Steps

7-step process to determine WRCs

7-step process to determine RQOs

Aligned

1. Delineate Resource Units (RUs)
2. Establish Vision for Catchment
3. Prioritise & select priority RU for RQO
4. Prioritise sub-components for RQO & select indicators
5. Draft RQOs & Numerical Limits
6. Agree to RU, RQOs and numerical limits with stakeholders
7. Finalise & Gazette RQOs

Gazette WRC & RQO

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Scenario Evaluation Process

Aim of the scenario evaluation process:

- An appropriate balance between the level of environmental protection and the use of the water to sustain socio-economic activities

Environmental Protection

Sustain Socio-economic Activities

Balance must consider 3 main elements:
1. Ecology
2. Economic benefits
3. Societal benefits

Scenario evaluation process estimates consequences of the scenarios on the three main elements

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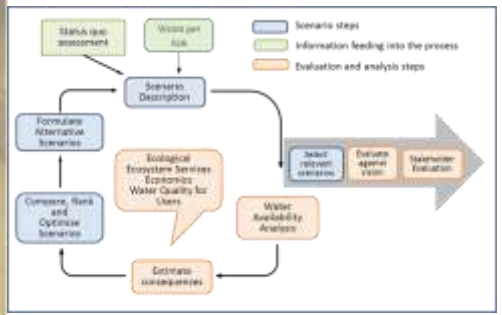
Methodology for Scenario Evaluation



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Vision for the Berg Catchment

Process of involving stakeholders in articulating future aspirations for the desired state and benefits to be derived

Promotes equity and shared understanding of the costs and benefits of different resource options.

PSC members are given an opportunity to express their vision for each IUA

Questions asked to establish a Vision Include:
1. What should be changed (in the IUA)?
2. Why should these changes be made?
3. What are the possible consequences?
4. What are our water resource issues in this IUA?

Scenarios for each IUA are developed considering inputs from PSC vision

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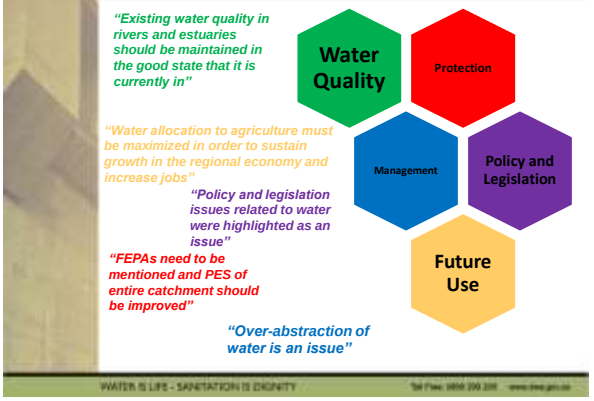
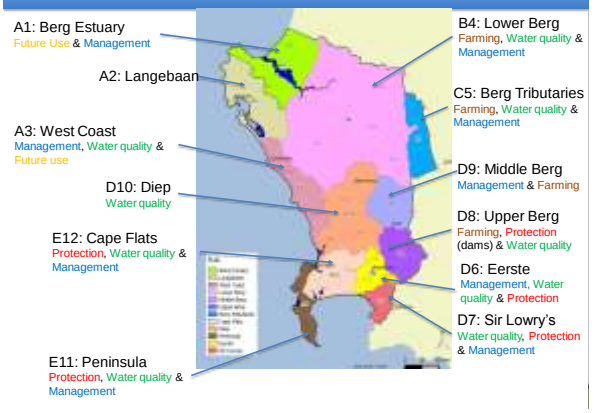
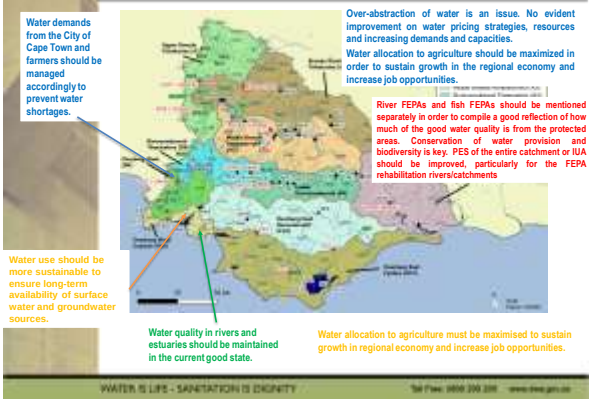
Themes for Visioning Exercise



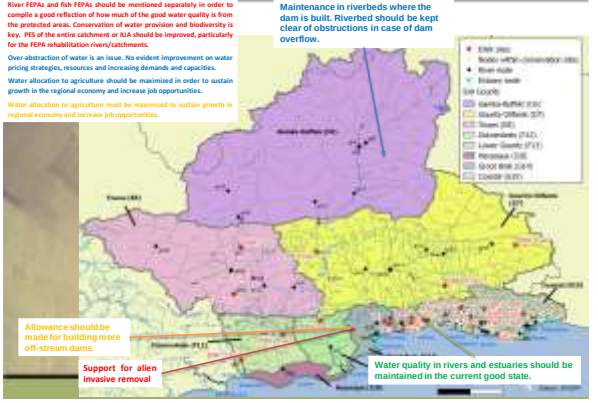
Visioning the future of the Berg catchment



Vision for the Breede-Overberg region



Vision for the Gouritz-Outeniqua region

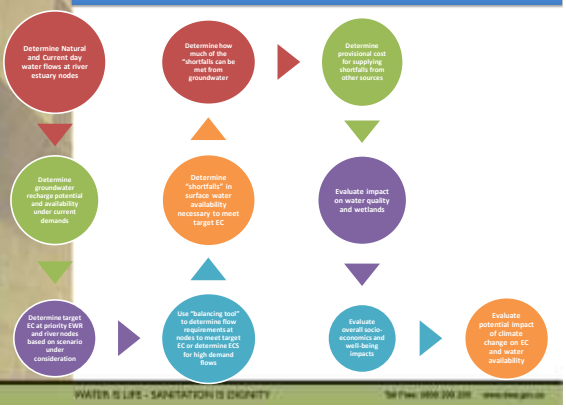


Scenarios Considered

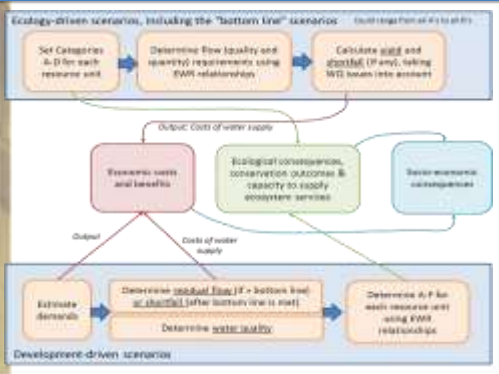
Rationale for scenarios analysis:

- Explore the potential water supply, biodiversity and socio-economic outcomes of a range of potential classification options against a range of demand contexts and climate contexts
- Large number of protection and contexts, thus useful subset chosen
- Four levels of protection: **(1)** Maintain Present Ecological status **(2)** The Baseline (PES) **(3)** Reducing Protection to the Minimum allowable (ESBC) **(4)** Improving Protection to the level recommended from an ecological perspective (REC)
- Impact of scenarios on the costs of water infrastructure and supply of shortfalls, was evaluated against current and future demands.
- Scenarios are developed based on the ecological condition targeted at each node under the specific scenario and its associated EWR flows at all river, and estuary nodes, flow regime, estimated water demands and the current/proposed future water supply water infrastructure

Methodology for Scenario Evaluation



Scenario Development



Scenarios Considered

#	Scenario
1	Maintain Present Ecological Status ("Baseline")
2	Ecologically Sustainable Base Configuration (ESBC) ("Bottom-line")
3	Recommended Ecological Categories (RECs)
4	High future demands met with no bottom-line constraint on ecological condition (i.e. No EC)
5	Climate Change (10% "dry")
6	Spatially Targeted (mixed)

Note: Consequences of meeting the targeted ECs determined for current and future demands.

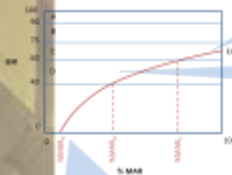
Spatially targeted (mixed) scenario

- **REC replaced with ESBC** (which has lower water requirements) for all nodes in each of the eight IUAs with the highest infrastructure costs to implement the REC under 2040 water requirements
- Unless that node was associated with **special conservation areas** (e.g. protected area, strategic water source area, NFEPA), in which case the REC water requirement values (EWRs) were retained.

IUA Name	IUA	Estimated total infrastructure costs to meet future demands and EWR requirements under each scenario.	
		ESBC	REC
Overberg West Coastal	H16	R 306 million	R 300 million
Overberg East Fynbos	H17	R 103 million	R 308 million
Upper Breede Tributaries	A1	R 75 million	R 303 million
Breede Working Tributaries & Middle Breede	A2 + A3	R 296 million	R 550 million
Riversonderend Theewaters	B4	R 3 million	R 197 million
Gouritz-Olifants	D7	R 383 million	R 771 million
Coastal	G15	R 394 million	R 672 million

Ecological Category	PES % Score	Description of the habitat
A A/B	92-100% 87-92%	Still in a Reference Condition
B B/C	82-87% 77-82%	Slightly modified from the Reference Condition. A small change in natural habitats and biota has taken place but the ecosystem functions are essentially unchanged
C C/D	62-77% 57-62%	Moderately modified from the Reference Condition. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged
D D/E	42-57% 37-42%	Largely modified from the Reference Condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred
E E/F	22-37% 17-22	Seriously modified from the Reference Condition. The loss of natural habitat, biota and basic ecosystem functions is extensive
F	0-17%	Critically/Extremely modified from the Reference Condition. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible

ESTUARIES



3. It is often not possible to restore health to 100% of natural through restoration of flow alone due to other non-flow related impacts

1. Relationship between health and flow is logarithmic – health declines increasingly rapidly as %MAR declines

2. The ability of an estuary to support biodiversity drops to zero before MAR drop to zero

A. Models were developed which allowed us to project likely changes in estuary health from A to E category as flows decline based on data from Reserve determination studies for individual estuaries

B. Proportional changes in the size of macrophyte, invertebrate, fish and bird populations were also estimated using matrices developed using data from Reserve determination studies for individual estuaries

		Assigned Ecological Category					
		A	B	C	D	E	F
PES	A	1.0	0.9	0.7	0.5	0.3	0.1
	B	1.2	1.0	0.8	0.6	0.4	0.1
	C	1.4	1.2	1.0	0.7	0.4	0.1
	D	1.9	1.7	1.4	1.0	0.6	0.2
	E	3.2	2.8	2.3	1.7	1.0	0.3
	F	10.4	9.0	7.3	5.4	3.2	1.0

Use of the "balancing tool" to determined ECs and nodal shortfalls (or surpluses) for Scenarios

Node	River	REC	Current		Scenarios							
			PES (2014)	% nMAR	ESBC		REC		HighDev		CC(10)	
					EC	% nMAR	EC	% nMAR	EC	% nMAR	EC	% nMAR
gii5	Duiwenhoks		E	93.3	E	51.7	E	93.3	E	91.5	E	71.6
gv11	Duiwenhoks		D	93.2	D	51.0	D	93.2	D	91.7	D	70.3
gii8	Duiwenhoks	D	D	93.5	D	50.1	D	93.5	D	92.1	D	70.4
Gvi2	Duiwenhoks estuary	A	B	91.1	C	48.8	B	91.1	B	89.8	B	67.8
gii6	Korinte		D	88.1	D	48.8	D	88.1	D	80.6	D	62.5
gii7	Goukou	C/D	C/D	87.0	D/E	31.7	C/D	87.0	C/D	87.0	D	61.0
gv10	Goukou		D	83.9	D	51.3	D	83.9	D	81.1	D	58.9
gv41	Goukou		C	82.5	C/D	47.7	C	82.5	C	80.0	C	56.9
Gvi3	Goukou estuary	B	C	80.6	C/D	46.8	C	80.6	C	78.3	C	55.0

Use of the river and estuary nodes for assessment of water quality and wetland consequences

Node	River	REC	Current		Scenarios							
					ESBC		REC		HighDev		CC(10)	
			PES (2014)	% nMAR	EC	% nMAR	EC	% nMAR	EC	% nMAR	EC	% nMAR
gii5	Duiwenhoks		E	93.3	E	51.7	E	93.3	E	91.5	E	71.6
gv11	Duiwenhoks		D	93.2	D	51.0	D	93.2	D	91.7	D	70.3
gii8	Duiwenhoks	D	D	93.5	D	50.1	D	93.5	D	92.1	D	70.4
Gxi2	**Duiwenhoks estuary**	A	B	91.1	C	48.8	B	91.1	B	89.8	B	67.8
gii6	Korinte		D	88.1	D	88.1	D	88.1	D	80.6	D	62.5
gii7	Goukou	C/D	C/D	87.0	D/E	31.7	C/D	87.0	C/D	87.0	D	61.0
gv10	Goukou		D	83.9	D	51.3	D	83.9	D	81.1	D	58.9
gv41	Goukou		C	82.5	C/D	47.7	C	82.5	C	80.0	C	56.9
Gxi3	**Goukou estuary**	B	C	80.6	C/D	46.8	C	80.6	C	78.3	C	55.0

Wetland assessment according to river linked wetlands (i.e. floodplain and valley bottom) with Ecostatus

Water quality assessment referring to the status quo assessment related to river/estuary node

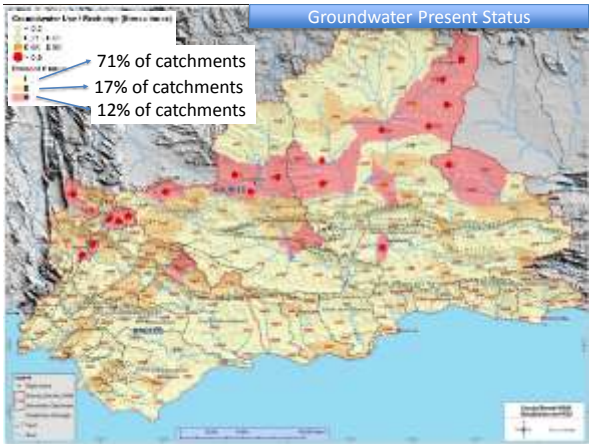
Scenario consequences on groundwater condition

- Definition for groundwater status relates to alteration from pre-development state: informed by use/recharge ('stress') ratio
- Level of 'stress' used to determine the resulting groundwater status per water resources classification scenario, resulting from increases in groundwater use for future development, or meeting surface water deficits

Groundwater Status Category		Generic Description	Use/ Recharge (Stress)
I	Minimally used	The water resource is minimally altered from its pre-development condition	≤20%
II	Moderately used	Localised low level impacts, but no negative effects apparent	20-65%
III	Heavily used	The water resource is significantly altered from its pre-development condition	>65%

(modified from Dennis *et al*, 2013)

Groundwater Present Status

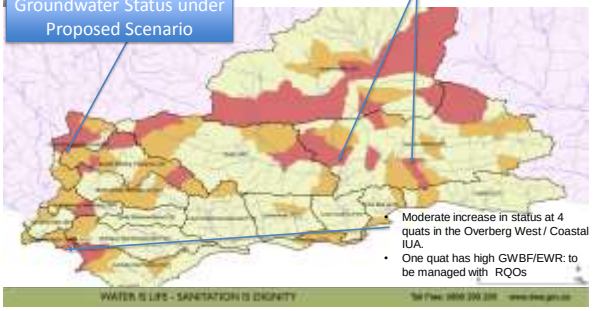


Spatially Targeted and Mixed : consequences for groundwater condition

- Increase in status at 4 quats in the Upper Breede.
- 2 of these have significant increase.
- None are high GWBF/EWR.

- Moderate increase in status at 7 quats in the Gouritz-Olifants IUA.
- 4/7 change from I to III
- None are high GWBF/EWR.

Groundwater Status under Proposed Scenario



- Moderate increase in status at 4 quats in the Overberg West / Coastal IUA.
- One quat has high GWBF/EWR: to be managed with RQOs

Scenario Consequences on EGSAs

- Models of relationships between freshwater flows, estuary characteristics, estuary health and the delivery of EGSAs were developed to allow prediction of changes to EGSAs under different flow scenarios

ESGA Topic
Tourism
Property Value
Combined Aquatic Ecosystem services
Subsistence Fishing Value
Nursery Value

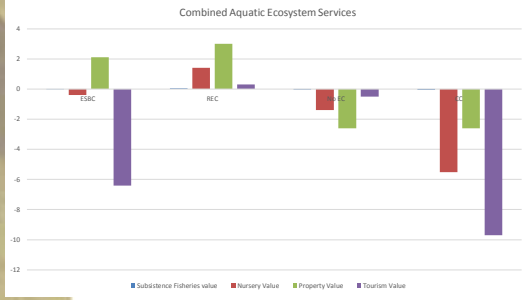
Resulting changes that would be expected under each scenario were outlined in the following EGSA topic

Main ecosystem services used in analysis

Category of service		Types of values	Description of EGSA	Independent variables related to estuary condition
Goods (Provisioning services)		Subsistence fishing	Invertebrates and fish collected on a subsistence basis for consumption or bait	Invertebrate abundance Freshwater fish abundance Estuary line- and net fish abundance
Services (Regulating services)		Nursery value	Contribution to marine fish catches due to the nursery habitat provided by estuaries	Abundance of estuary-dependent marine fish
Attributes (Cultural services)		Tourism value & property value	A river, wetland or estuary's contribution to recreation/tourism appeal of a location	Overall health Line fish abundance Water quality

Combined Aquatic Ecosystem Services

Summary of changes to the aquatic ecosystem services of estuaries under the different scenarios



Scenario consequences for water availability and supply

1. Define the scenarios
2. Describe surface flows and ecological conditions (EC)
3. Quantify changes in flow and ecological conditions
4. Determine consequences for available yield and water supply
   a) Determine deficits/shortfalls in meeting targeted ECs.
   b) Provisional cost estimates for additional water supply options to meet shortfalls when meeting targeted ECs.

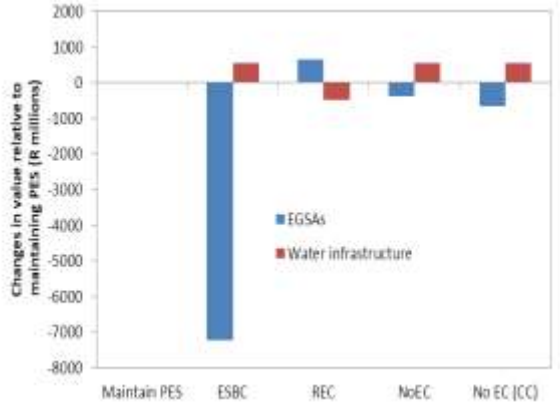
Scenario consequences for water availability and supply

WMA portion	IUA	Future (2040) total water requirements (million m³/a)	Net surplus/deficit (million m³/a) under 2040 water requirements		
			Maintain PES	ESBC	REC
Breede	B5	60.4	-4.5	77.5	-4.5
	H16	32.7	-9.3	-8.3	-12.0
	H17	20.4	0.5	2.4	-17.1
	F10	9.8	-	44.9	-2.5
	A1	111.8	--34.1	67.1	-33.3
	A2 + A3	442.3	-70.9 (-105.0)	-24.8 (42.3)	-75.7 (-109.0)
	B4	42.0	-0.2	12.8	-19.2
	F9	17.7	-0.4 (-0.6)	16.0 (28.8)	-0.4 (-19.6)
	F11	39.5	-8.3 (-113.9)	-70.4 (1.71)	-8.3 (-136.9)
	Sub-total	776.6	-127.2	117.2	-173

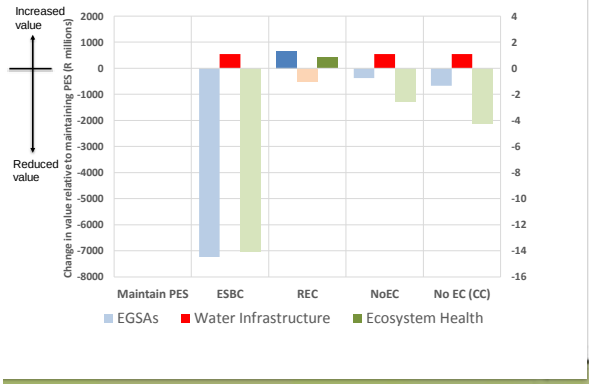
Scenario consequences for water availability and supply

WMA portion	IUA	Future (2040) total water requirements (million m³/a)	Net surplus/deficit (million m³/a) under 2040 water requirements		
			Maintain PES	ESBC	REC
Breede	Sub-total	776.6	-127.2	117.2	-173
Gouritz	E8	50.4	-0.8	5.9	-0.8
	C6	23.3	-2.1	19.5	-2.1
	D7	151.0	-11.9	20.7	-36.8
	F13	4.6	-0.8 (-15.6)	77.9 (124.0)	-0.8 (-40.8)
	F12	13.1	-3.6	40.0	-3.6
	I18	4.7	-	0.5	-
	G14	22.3	-7.5	16.2	-7.5
	G15	68.4	-35.4	254.7	-42.4
	Sub-total	337.8	-62.1	435.4	-94
Total for WMA		1114.4	-121.1	552.6	-267

Overall socio-economic consequences



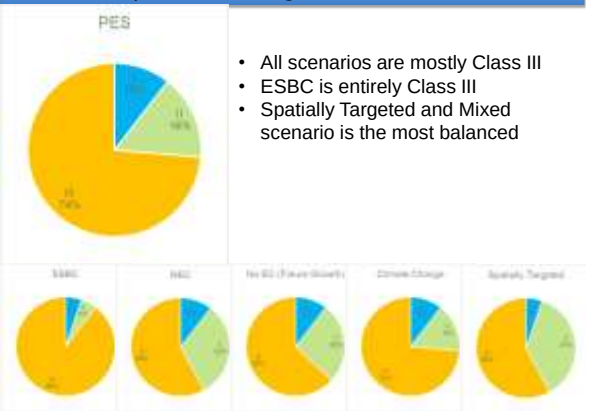
Overall Scenario Comparison



Overall Scenario Comparison

Rank	Scenario	Ecological condition	Groundwater	EGSAs	Socio-econ
1	Spatially targeted	A nice balance of ecological conditions, similar to baseline.	Increase in groundwater use, alleviated in some cases.	Improves EGSAs	Costs not too significant for infrastructure
2	REC	Improvements in ecological conditions based on flow alone for some areas, others require other interventions.	Significant increase in groundwater use.	Improves EGSAs	High cost to implement REC
3	No EC - Future growth	Reductions in ecological conditions, but not as severe as the ESBC scenario, downstream WQ deteriorates.	Although has biodiversity impacts it alleviates pressure on groundwater.	Significant decreases to EGSAs	Most costly to implement
4	No EC - Climate change	Impacts of climate change worse for ecological conditions than the other scenarios. Reduced flow and increased evaporation will aggravate impacts on water quality.	Increase in groundwater use.	Largest decrease to EGSAs.	High cost
5	ESBC	Reduced ecological conditions, severe impacts at Gouritz estuaries, downstream WQ deteriorates.	-	Significant decreases to EGSAs.	High cost for additional infrastructure

Comparison of Resulting Water Resource Classes



- All scenarios are mostly Class III
- ESBC is entirely Class III
- Spatially Targeted and Mixed scenario is the most balanced

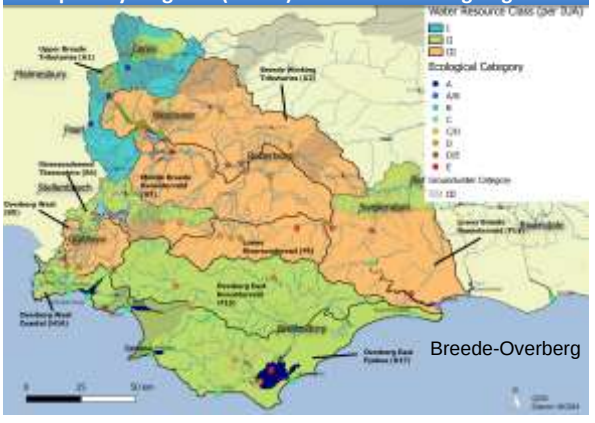
Spatially Targeted Classification Scenario

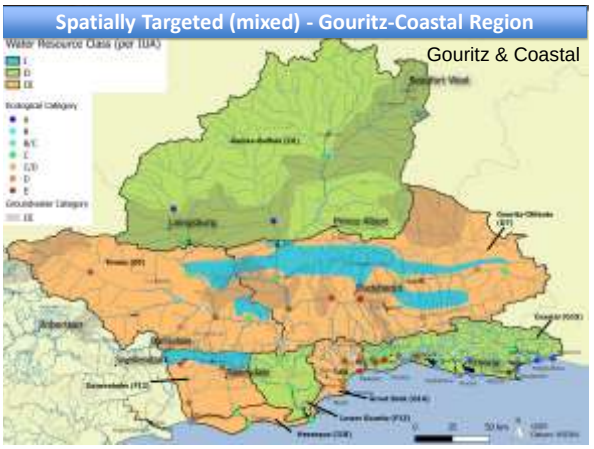
- Developed in order to give appropriate recognition to spatial variations of priority objectives inside individual IUAs
- Blend of targeted ECs for all nodes ranging between REC and ESBC
- Considerations to guide derivation of this scenario:
  - Balance competing ecological requirements, conservation priorities, projected future demands and development opportunities inside individual IUAs
  - REC water requirements at all nodes are logical starting points
  - REC water requirements at ESBC level for certain individual nodes or cluster of nodes
  - EC downgrades to ESBC level not considered for nodes associated with special conservation areas
  - Focus points across WMA for potential EC downgrades relative to REC, are IUAs with highest total infrastructure costs to meet environmental water requirements
  - Stakeholder inputs- prerequisite for appropriate selection of nodes for potential EC downgrades below REC level in each IUA

Comparison of Resulting Water Resource Classes

	IUA		PES - Baseline	ESBC - Bottom line	REC	NoEC (Future Growth)	Climate change (10%)	STS
Breede-Overberg	Upper Breede Tributaries	**A1a**	I	III	I	I	I	I
	Upper Breede Tributaries	A1b	III	III	III	III	III	III
	Middle Breede Renosterveld	A2	III	III	III	III	III	III
	Breede Working Tributaries	A3	III	III	III	III	III	III
	Riversonderend Theewaters	**B4a**	II	III	II	II	II	II
	Riversonderend Theewaters	B4b	III	III	III	III	III	III
	Lower Riversonderend	F9	III	III	III	III	III	III
	Overberg West	**B5**	III	III	III	III	III	III
	Overberg West Coastal	**H16**	III	III	III	III	III	II
	Overberg East Renosterveld	F10	III	III	III	III	III	II
	Overberg East Fynbos	H17	III	III	III	III	III	III
	Lower Breede Renosterveld	**F11a**	II	III	II	II	II	II
	Lower Breede Renosterveld	F11b	III	III	III	III	III	III
Gouritz-Coastal	Gamka Buffels	C6	II	III	II	II	II	II
	Touws	E8	II	III	II	III	III	III
	Gouritz-Olifants	D7	III	III	III	III	III	III
	Lower Gouritz	F13	II	III	III	III	III	II
	Duiwenhoks	**F12a**	III	III	III	II	II	III
		F12b	III	III	III	III	III	III
	Hessequa	I18	III	III	III	II	II	III
	Groot Brak	G14	III	III	III	III	III	III
	Coastal	**G15**	II	III	II	II	II	II

Spatially Targeted (mixed) - Breede-Overberg Region




Spatially Targeted (mixed) - Gouritz-Coastal Region
Gouritz & Coastal