Use of dragonfly insects in assessing freshwater ecosystems

Kwitonda Philippe (Msc, lakes and wetlands management)

Leave no method behind!

Orthetrum julia capicola.

Orthetrum caffrum

Sympetrum fonscolombii

Why dragonfly?

- Bio-indicators which are sensitive to environmental change
- They are easily identifiable
- Sampling can be done on three life stages: larvae, exuviae and adults
- Merit of being relatively easy, rapid, reliable and cost-effective methods for assessing freshwater ecosystems
- They constitute part of biological assessment methods

Table 1 Advantages of using adult dragonflies versus aquatic macroinvertebrates
Strength scores: 1 = high, 2 = medium, 3 = low.

Attribute	Dragonflies	Macroinvertebrates
Widespread use	1	1
Social appreciation	1	3
Easy identification at species level	1	3
Laboratory work	1	3
Overtime integration of effect	1	1
Sensitive to environmental change	1	2
Reflect the wetland condition	1	1

Source: Adapted from U.S. EPA 2002

Dragonfly indices

- **Index**: Dragonfly species are assigned a score (0 to 10/9) depending on their affinity to degradation status of freshwater habitats in which these species are found

- There are **three** commonly used indices using adult dragonfly:

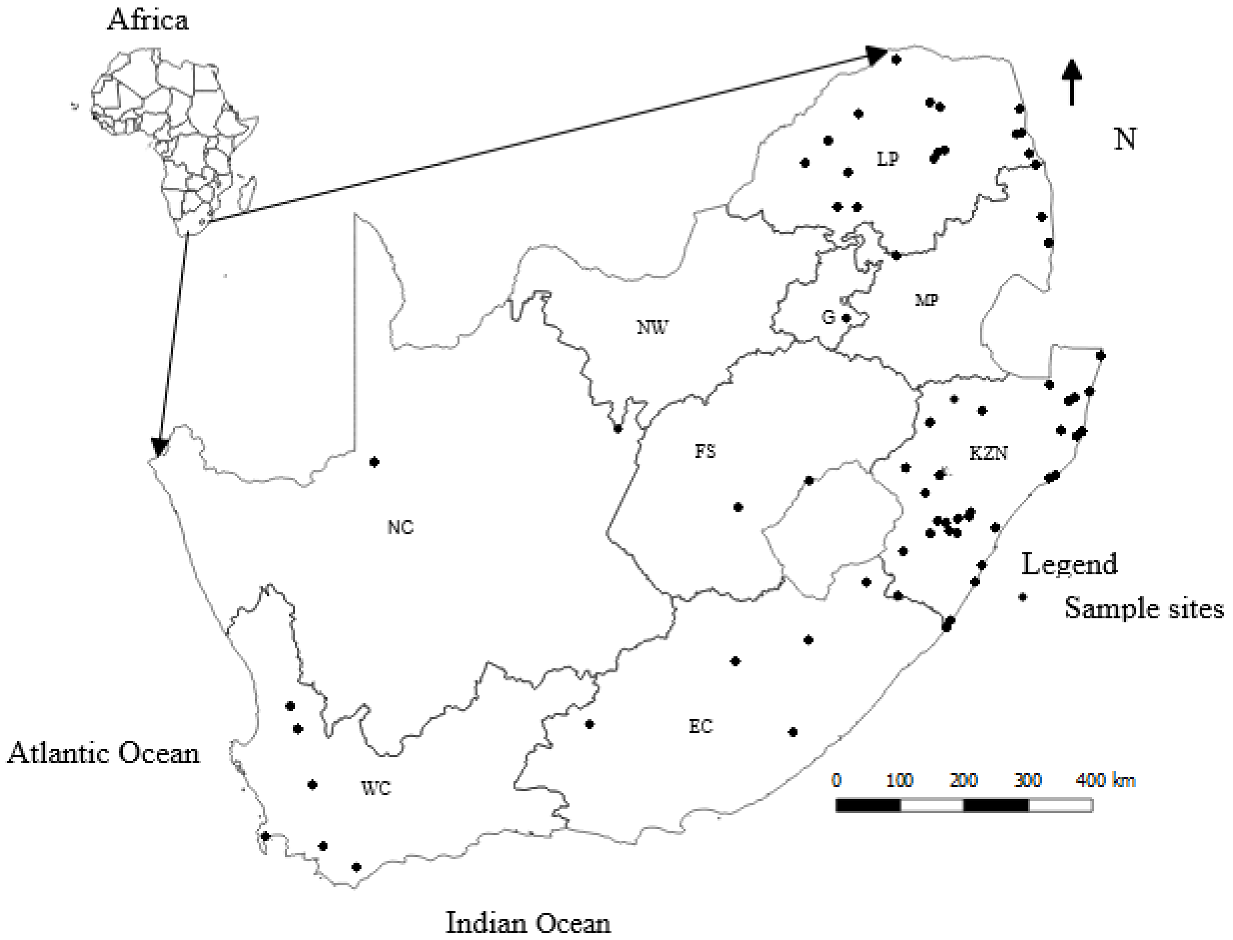
  Odonata Index of wetland Integrity (OIWI);

  Dragonfly Association Index (DAI);

  Dragonfly Biotic Index (BDI).

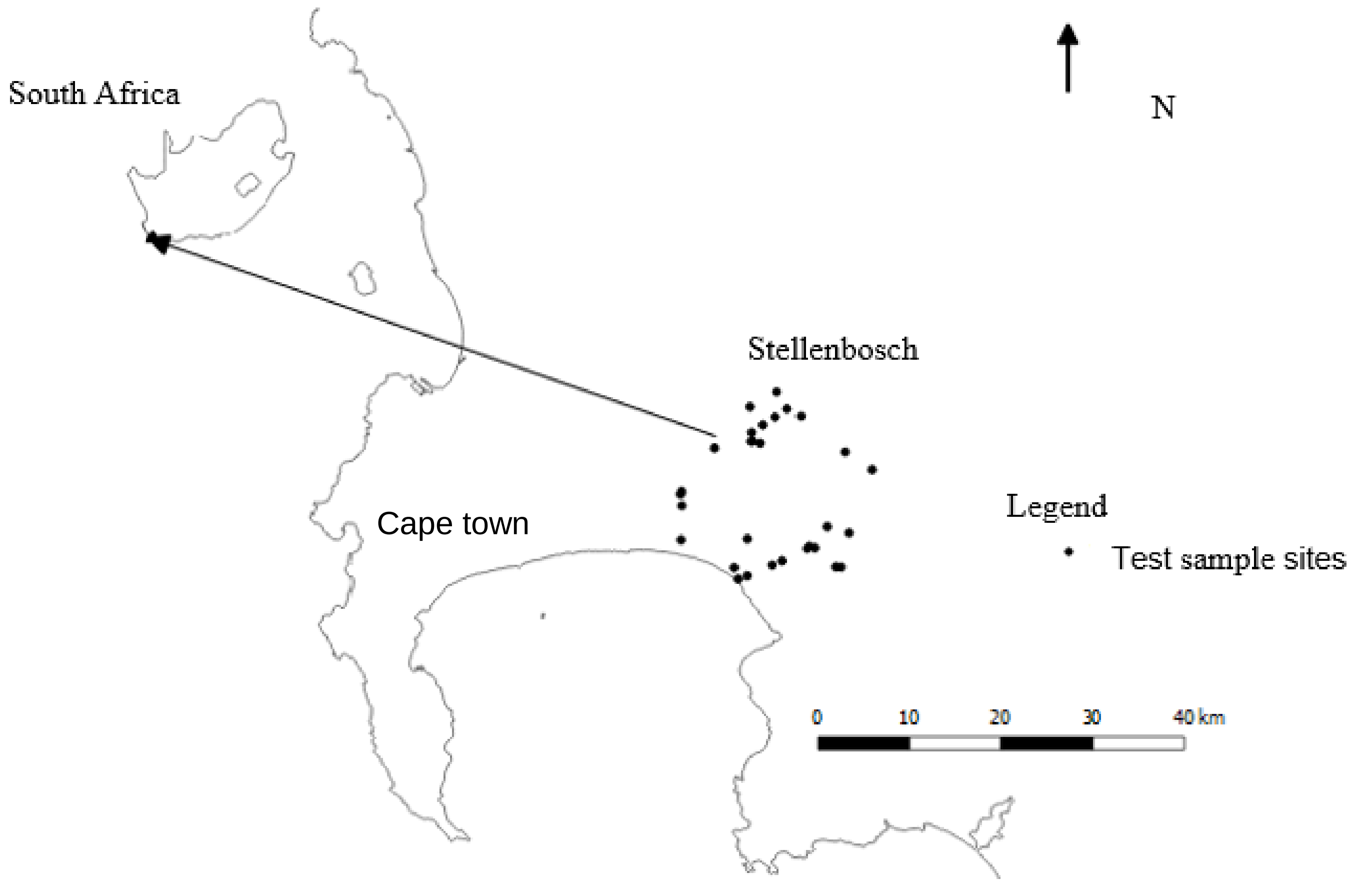
- Are these dragonfly indices **robust** in assessing ecological integrity of freshwater systems?

Sampling sites (68) across South Africa for developing indices



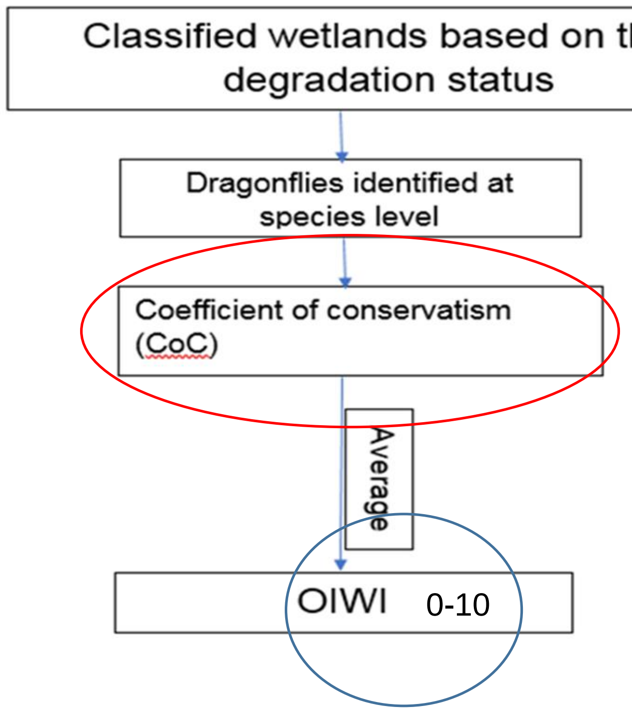
Provinces: KZN = KwaZulu-Natal; G = Gauteng; MP = Mpumalanga; LP = Limpopo; FS = Free State; NW = North West; NC = Northern Cape; EC = Eastern Cape; WC = Western Cape

Sampling sites (30) in Stellenbosch for testing adult dragonfly indices

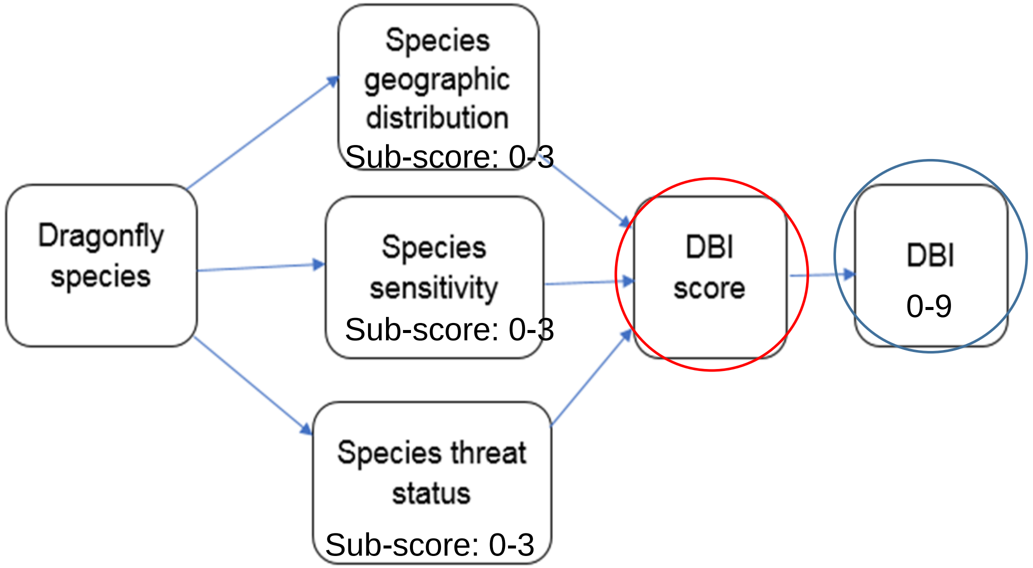


Indices computation

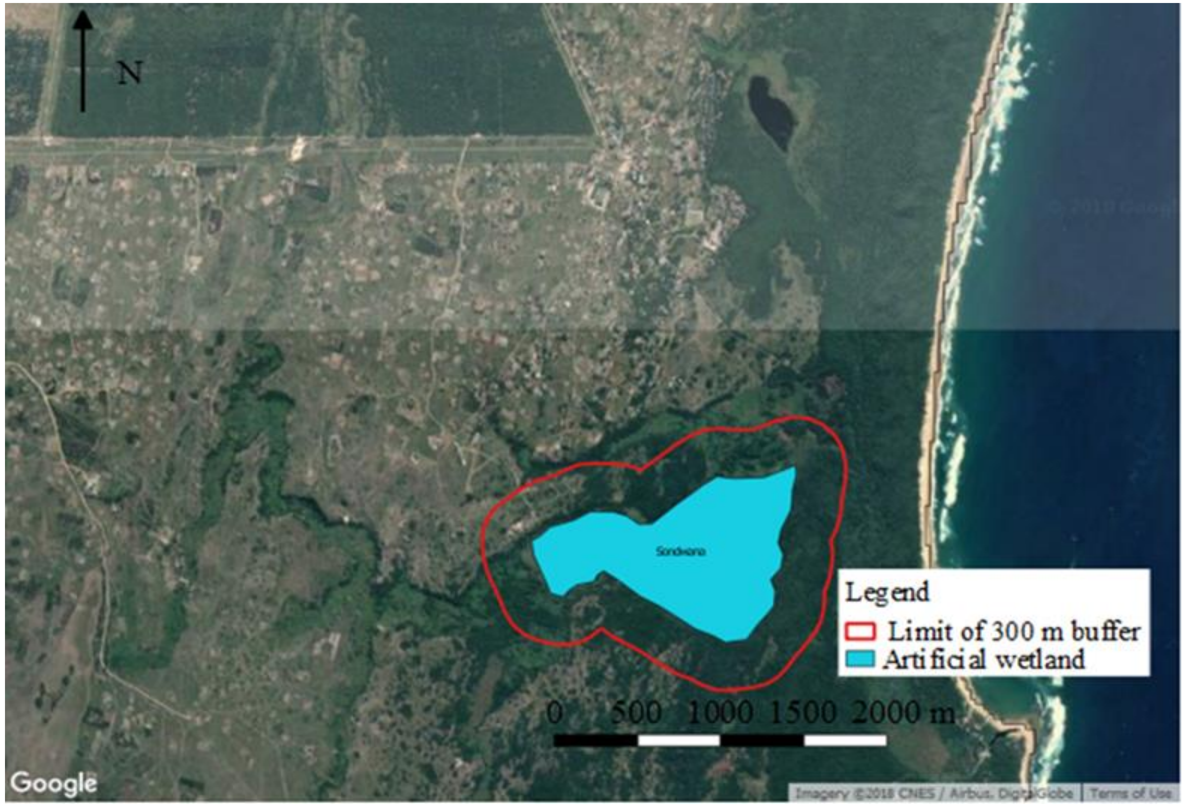
Odonata Index of Wetland Integrity (OIWI)



Dragonfly Biotic Index (DBI)



Determination of degradation status



Land cover was surveyed in 300 m buffer

Classification of wetlands (Kleynhans, 1996)

Wetland category		Explanation	Score [%]
Least disturbed	-	Near Pristine, natural, largely unmodified buffer	80-100
Moderately disturbed	-	Modified but some parts are still natural	50-79
Highly disturbed	-	Complete loss of natural habitat with small and scattered areas of natural vegetation	0-49

Examples of wetlands categorized

Categorization of artificial wetlands

No.	Name of artificial wetlands	Score of naturalness	Category
1	Abederee Karoo	100	Least disturbed
2	Augrabies Falls	90	Least disturbed
3	Bisley valley	100	Least disturbed
4	Bredasdorp	20	Highly disturbed
5	Burgersdorp	70	Moderately disturbed

Materials and methods**(cont’d)**

- **After getting wetland categories, CoC** was detemined empirically by using the formula by Dufrêne & Legendre (1996)

$$\left[\left(\frac{NLD}{N}\right) + (1 - NHD/N)\right] \div 2 * 10$$

NLD = Number of least disturbed artificial wetlands
HND = Number of highly disturbed artificial wetlands
N= Total number of artificial wetlands

- CoC varies from 0 to 10

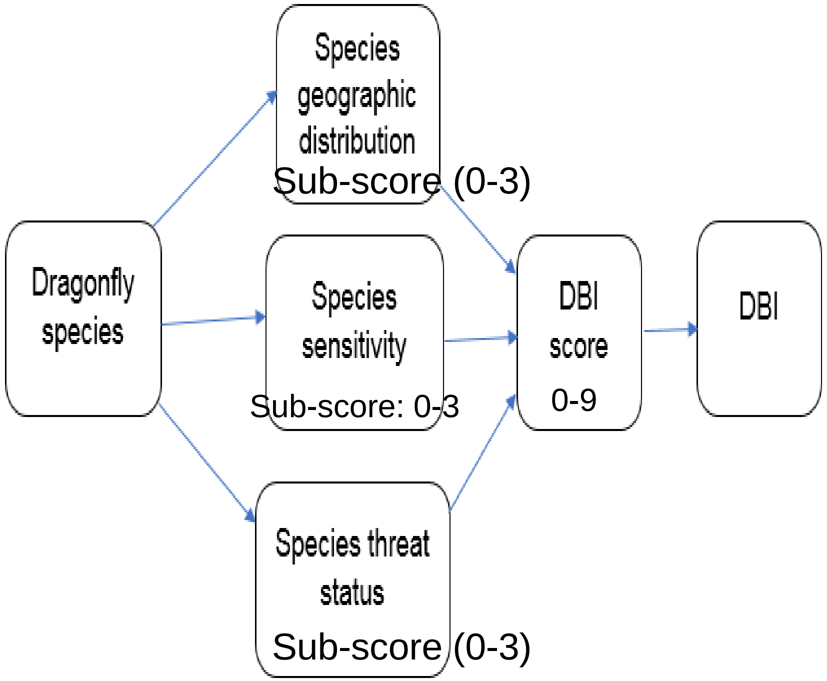
Materials and methods **(cont'd)**

Calculation of Coefficients of conservatism (CoC)

Artificial wetlands: LD = least disturbed, MD = moderately disturbed, HD = highly disturbed

No.	Species	LD	MD	HD	Total	CoC
1	*Aciagrion dondoense*	1	0	0	1	5.07
2	*Acisoma variegatum*	8	1	0	9	5.59
3	*Aethriamanta rezia*	2	0	0	2	5.15
4	*Africallagma elongatum*	1	0	0	1	5.07
5	*Africallagma glaucum*	14	5	7	26	5.51
6	*Africallagma sapphirinum*	2	1	3	6	4.93

Flowchart of Dragonfly Biotic Index development (DBI)



Calculation of DBI score

Species	Geographic distribution score/3	Sensitivity score/3	Threat status score/3	DBI score
Spesbona angusta	Rare	Very sensitive	Endangered(EN)	9
Crocothemis erythrea	Common	Very tolerant	Least concerned (LC)	0
Trithemis arteriosa	Common	Very tolerant	Least concerned (LC)	0
Pseudagrion furcigerum	Endemic to the Cape	Very sensitive	Near threatened (NT)	7

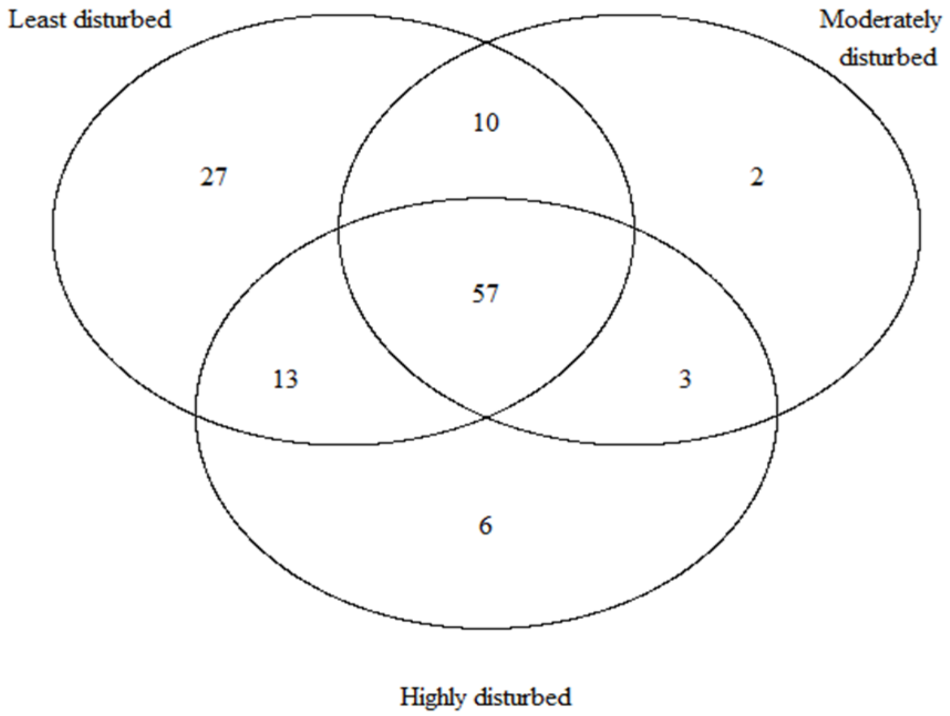
Species Score	Species distribution	Species threat	Species sensitivity
0	Most present in South Africa and southern Africa.	LC (GS and NS)	Not sensitive to habitat change but instead may take advantage of it due to alien vegetation. May prosper in artificial water systems.
1	Widely localized throughout South Africa and common in Southern Africa.	NT (GS and/or NS) or VS (NS)	Clearly low sensitivity to habitat disturbance from alien plants; And may be common in artificial water habitats.
2	They are nationally endemic and restricted to three or more South African provinces or very common in southern Africa but rare in South Africa.	VU (GS), or (EN), or CR (NS)	Moderate sensitivity to habitat alteration.
3	Endemic or near endemic and strictly confined only to one or two South African provinces.	EN or CR (GS) EN or CR (NS)	Highly sensitive to change of habitat from alien plants; Exclusive occurrence in near-pristine, natural habitat.

Results and discussion

- I found 973 individuals representing 118 species at 68 artificial wetlands (73% all dragonfly inventory in South Africa)(Simaika et al 2016).
- *Crocothemis erythraea, Trithemis arteriosa, Ischnura senegalensis* were more common at >50% of sites because these species are generalists and may indicate **habitat disturbance** for artificial wetlands (Samways & Simaika 2016; Acquah et al 2013).
- Zygotera were less dominant (34%) possibly because of their low ability to **dispersal** compared to Anisoptera (64%) and infrequent freshwater availability (Heiser & Schmitt 2010).

Results and discussion (**cont'd)**

The distribution of dragonfly species across three wetland categories



48 % (57 species) of 118 species are common

107 species at least disturbed artificial wetlands

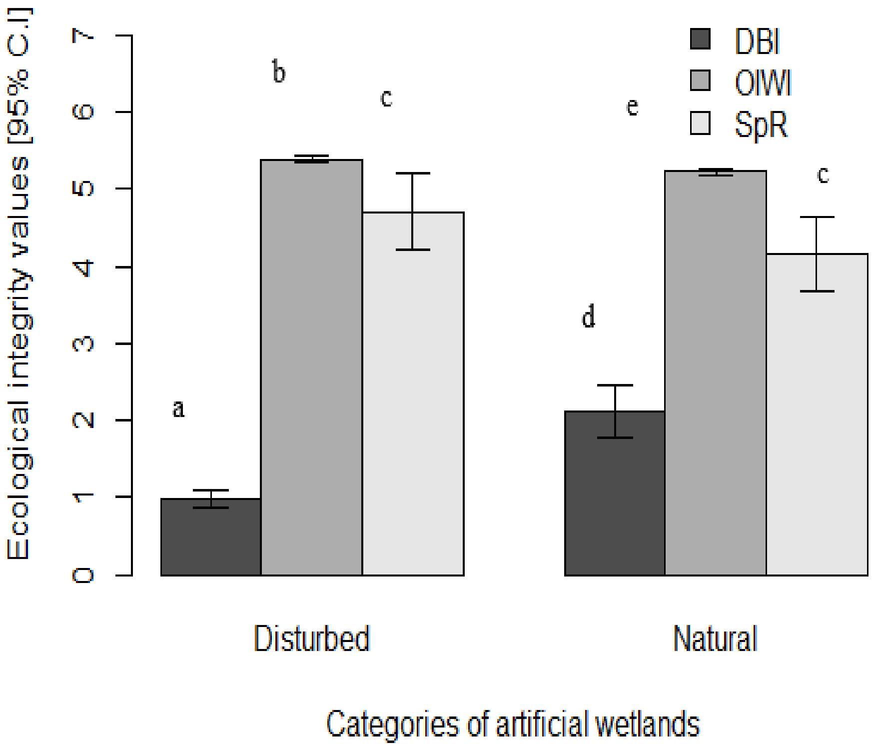
72 species were at moderately disturbed sites

79 species at highly disturbed artificial wetlands

Exclusive species are few which may suggest that most of species are euryotopic and can tolerate wide range of disturbance of artificial wetlands.

Results and discussion (**cont'd**)

Sensitivity of indices and species richness



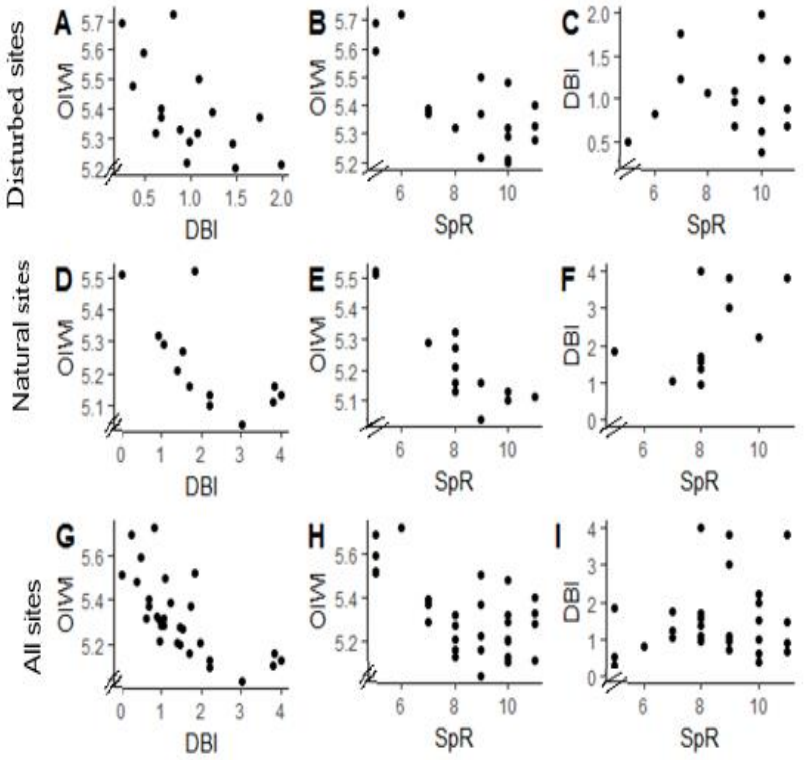
Wilcoxon rank sum test revealed that all indices are sensitive to habitat change (DBI, $p = 0.004$), (OIWI, $p = 0.005$)

Species richness did not differentiate those two categories of wetlands ($p = 0.32$)

- DBI seems to be more robust but may be constrained by requirement of enormous data for the first application.
- DBI provide additional information about species sensitivity.

Results and discussion (**cont'd**)

Correlations between OIWI, DBI and species richness



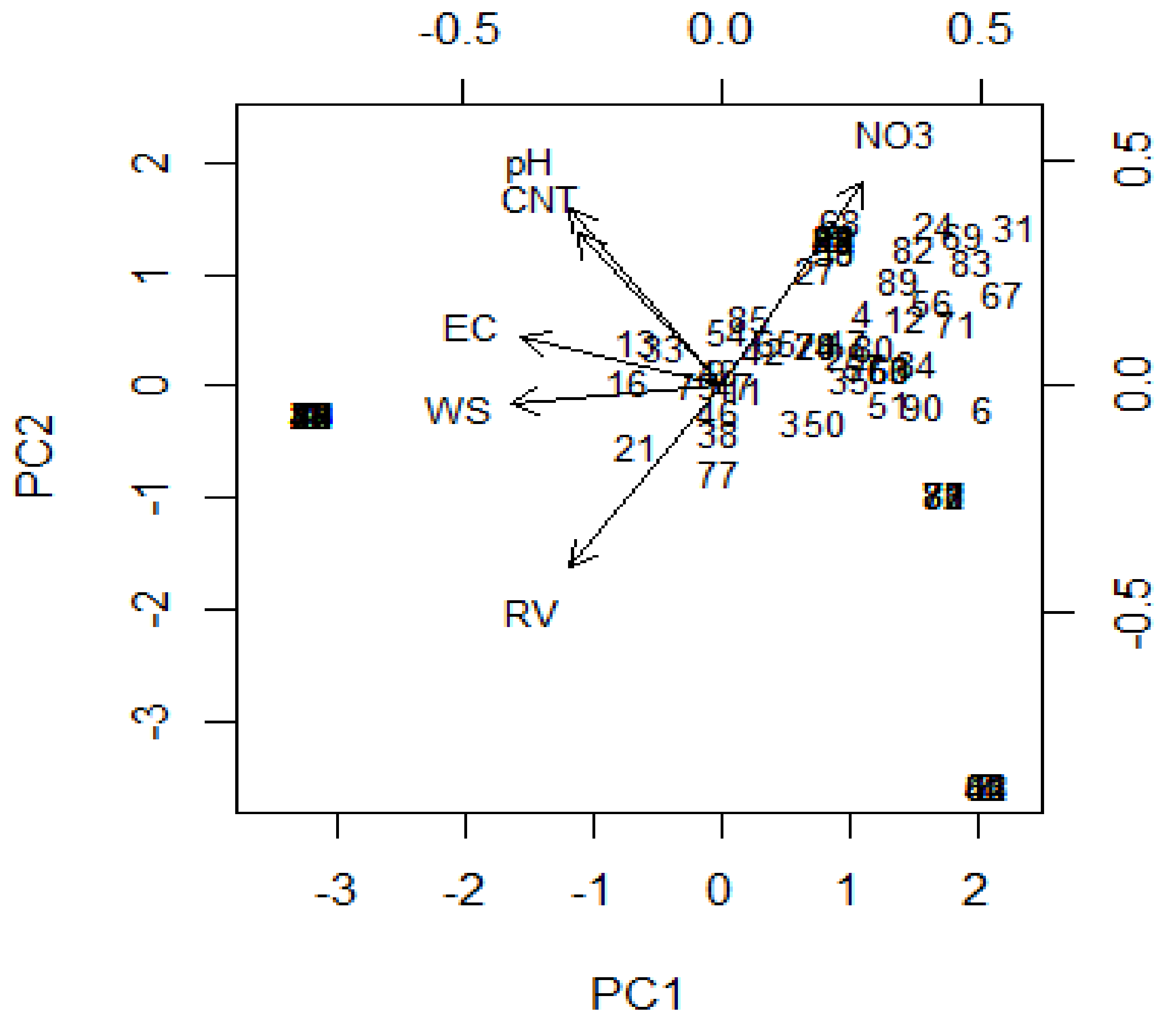
Strong negative correlation between DBI and OIWI, stronger at natural sites than at disturbed sites.

Stronger negative correlation between OIWI and species richness at natural sites than disturbed ones.

Stronger positive correlation between DBI and species richness at natural sites than at disturbed ones.

OIWI and DBI were both sensitive to habitat change but negatively correlated may be because of their different building frameworks: More occurring species were not sensitive.

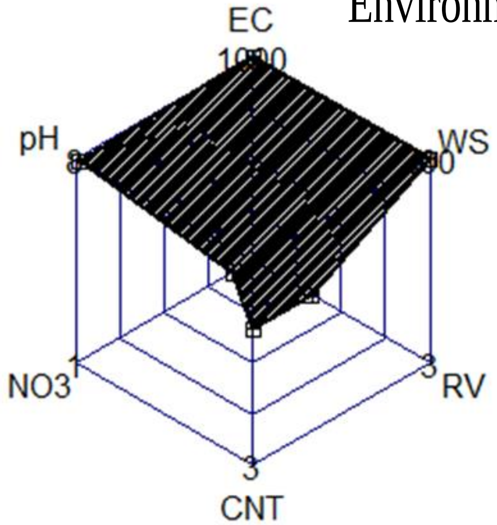
Site	Graph	OIWI and DBI	Graph	OIWI and SpR	Graph	DBI and SpR
Disturbed	A	r = -0.60, n= 17, p = 0.009	B	r = -0.55, n = 17, p = 0.021	C	r = 17, n = 17, p = 0.49
Natural	D	r = -0.72, n = 13, p = 0.005	E	r = -0.85, n = 13, p < 0.001	F	r = 63, n = 13, p = 0.02
All sites	G	r = -0.76, n = 30, p < 0.000	H	r = -0.47, n = 30, p = 0.002	I	r = 19, n = 30, p = 0.30



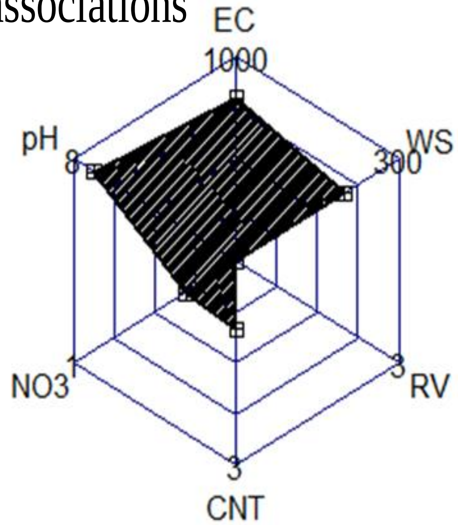
PC1
PC2
pH
CNT
NO3
EC
WS
RV

Results and discussion (**cont’d**)

A:Association with large artificial wetlands,EC and pH



E:Association with pH, EC and medium size wetlands



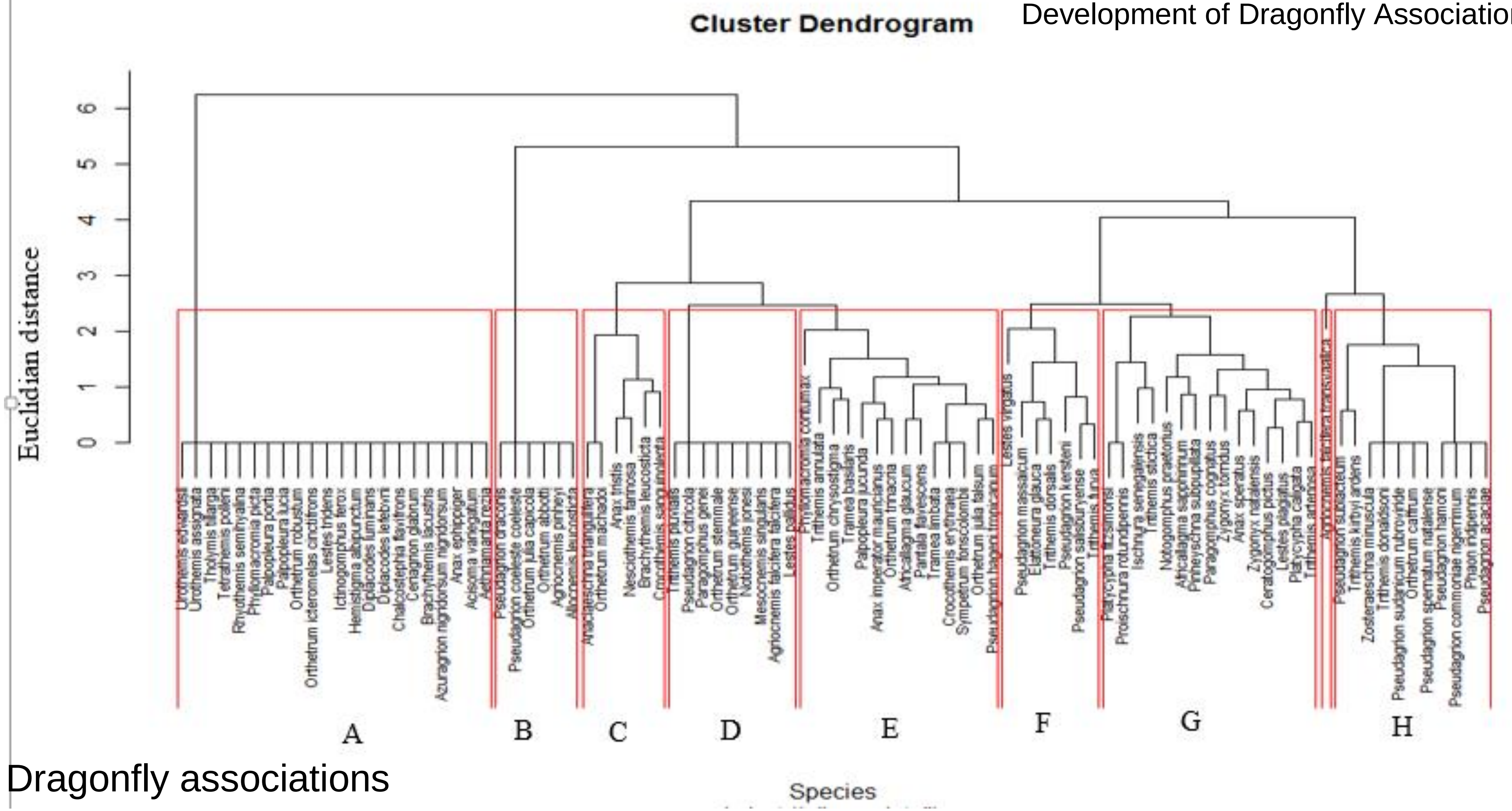
Environmental requirements of dragonflies associations

Wetland size (WS); Connectedness (CNT); Riparian vegetation (RV), Electrical conductivity (EC); Potential of hydrogen (pH) and Nitrate (NO3)

Dominance of *Crocothemis erythraea and Sympetrum fonscolombii*

Results and discussion (**cont'd)**

Development of Dragonfly Association index



8 Dragonfly associations

Conclusion and recommendations

- Use of dragonfly is cost-effective, environmental-freindly and does not require special skills
- Need to conduct a taxonomical study of dragonfly species in Rwanda
- To develop and avail standardized species score, usable for water quality monitoring.
- To integrate use of bio-indicators in water quality, freshwater ecosystems monitoring

THANKS