Towards a global typological framework to support Red Listing of ecosystems

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EcoHealth Alliance

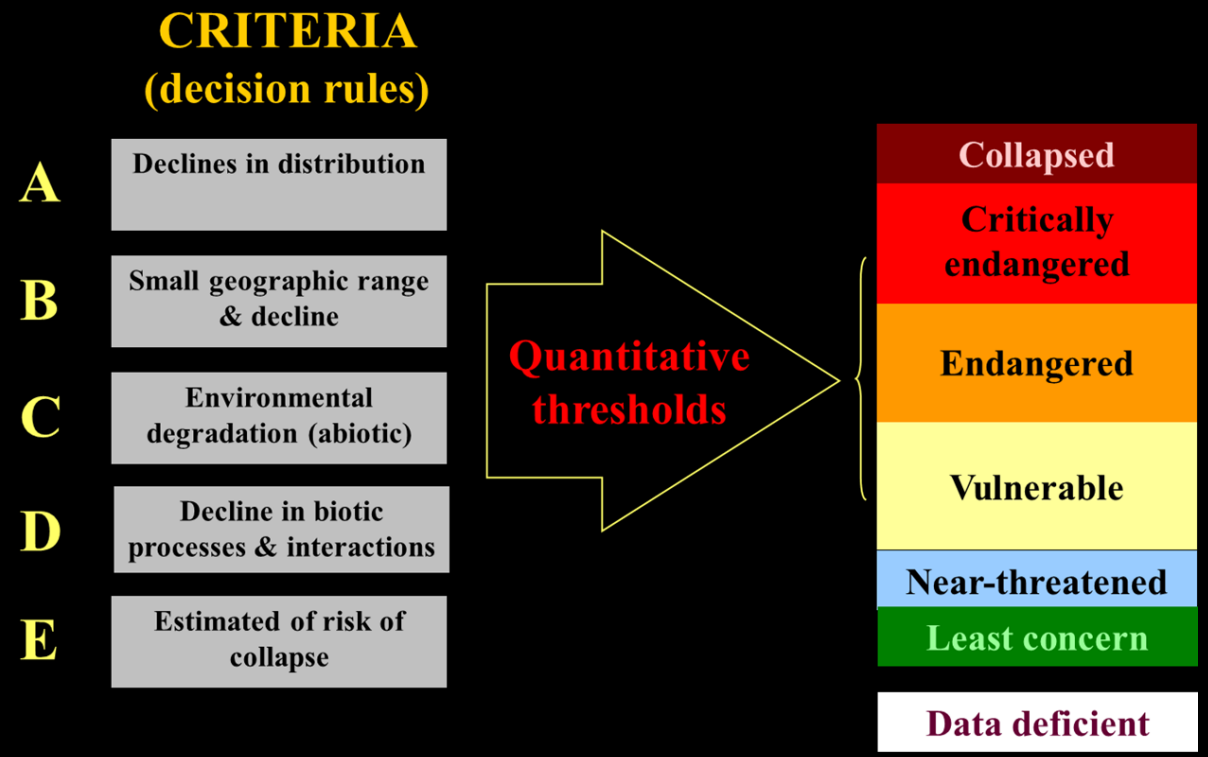
Mission: prevent pandemics in a changing world

Research:
How human activities (land use change) could lead to disease emergence (Ebola, Nipah, Zika, SARS, …)
Disease regulation as an ecosystem service.

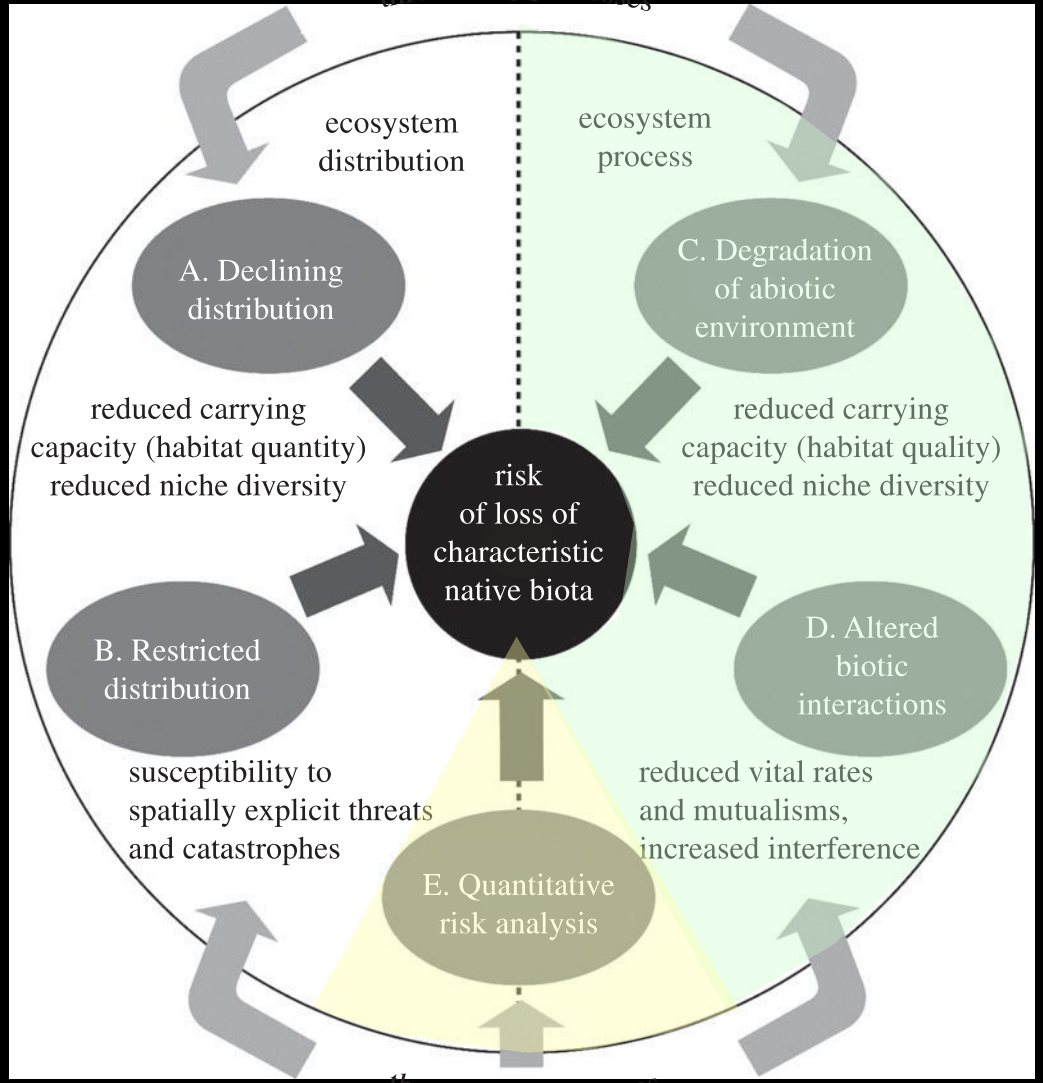
Red List of Ecosystems: a quantitative framework to evaluate ecosystem condition

Red List assessments of Ecosystems

Support conservation in resource use and management decisions by identifying ecosystems most at risk of biodiversity loss



for more info: http://iucnrle.org/

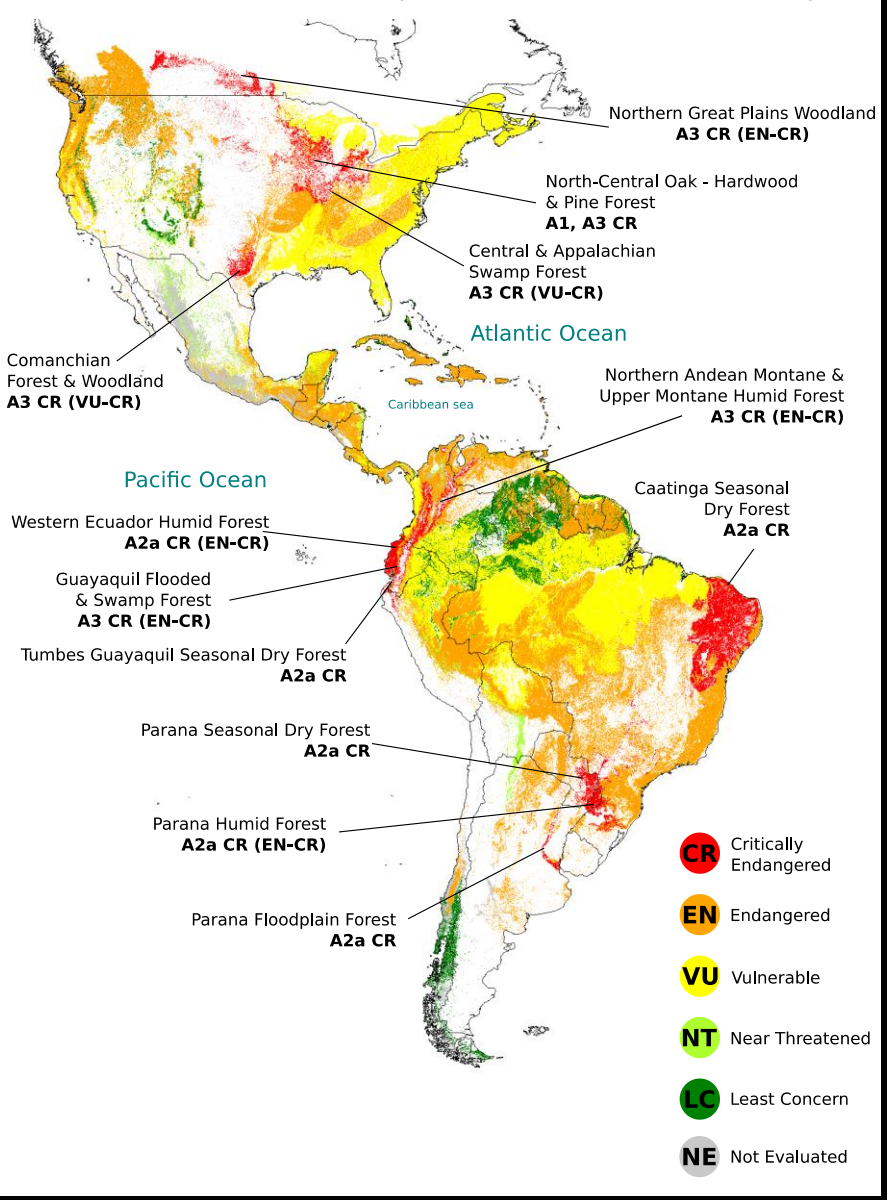


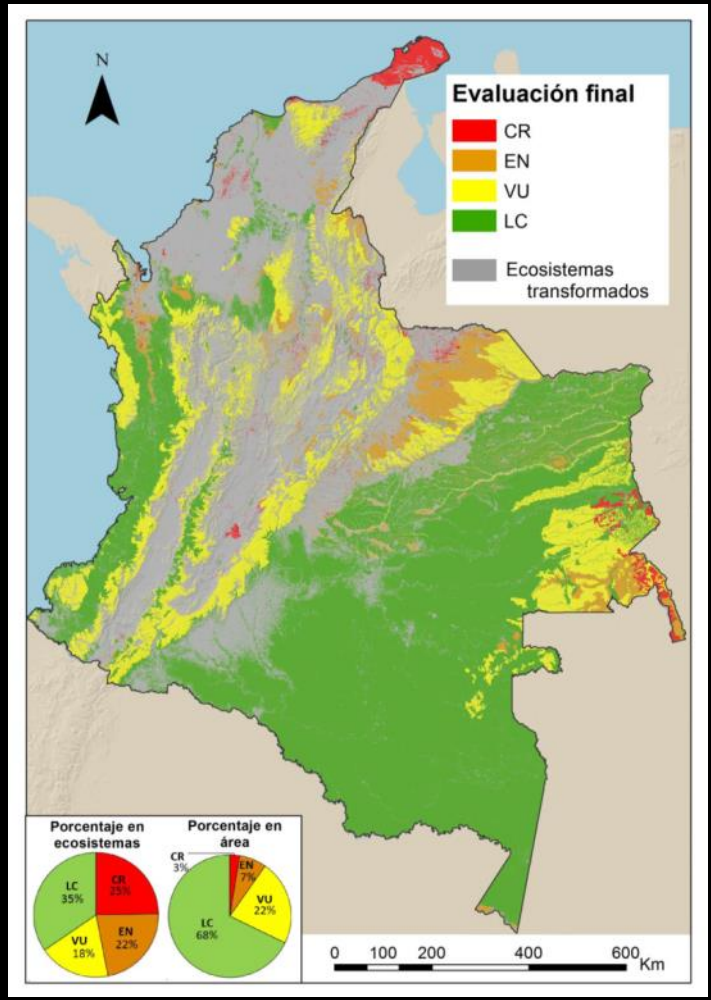
Application of the IUCN Red List of Ecosystems

- RLE assess **four** ecological symptoms to estimate risk of collapse
- Two distributional symptoms
- Two **functional** symptoms

- Multiple mechanisms may be integrated to produce a **quantitative** estimate of the risk of collapse

Some examples





Why another ecological classification?

- To conserve and manage ecosystems a **scalable, systematic and mappable** classification defining ecosystem types consistently is needed.
- We reviewed **20 existing global-scale** ecological classifications and found that none met all these needs.
  - Useful representation of biogeographic patterns, most **failed to incorporate ecological processes and functions**
- Representation of **ecological processes is essential** to support generalizations about ecosystem responses to environmental change and ecosystem accpunting

Qualities of a useful typological framework for Red Listing

- Representation of biota and ecological processes
  - generalisations about traits & responses to env'mental change
- Theoretical basis - scientific rigour & logical consistency
- Scalable structure – global/*national*/local applications
- Thematically comprehensive - all parts of the biosphere
- Spatially explicit - mappable units
- Parsimony

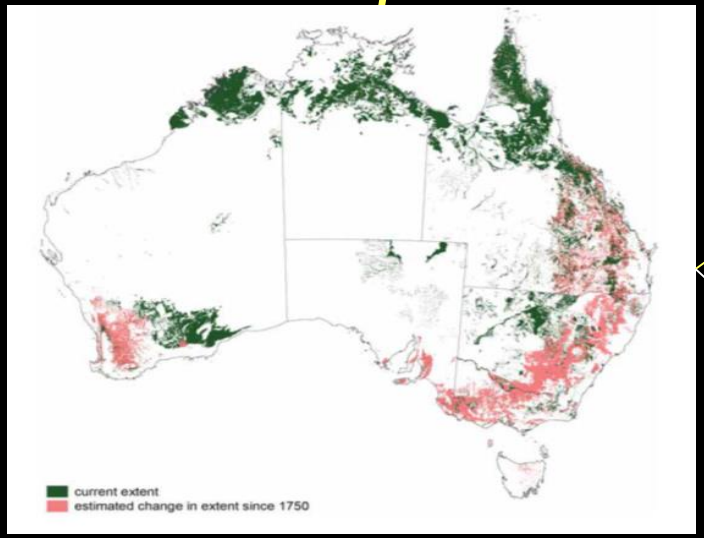
No existing framework has all six qualities

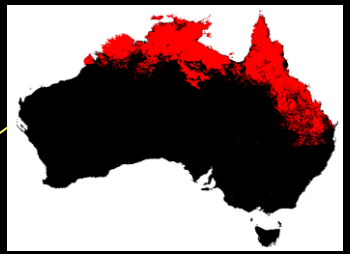
1. Standard terminology and definitions to promote consistency
2. Systematic profiles describing key ecological traits, functional processes and global distribution

1. Representing *ecological processes* in an ecosystem typology

Ecological processes – ecosystems with superficially similar structure may have fundamentally different organising processes

Structure *cf.* function





Tropical savanna woodlands

Temperate grassy woodlands

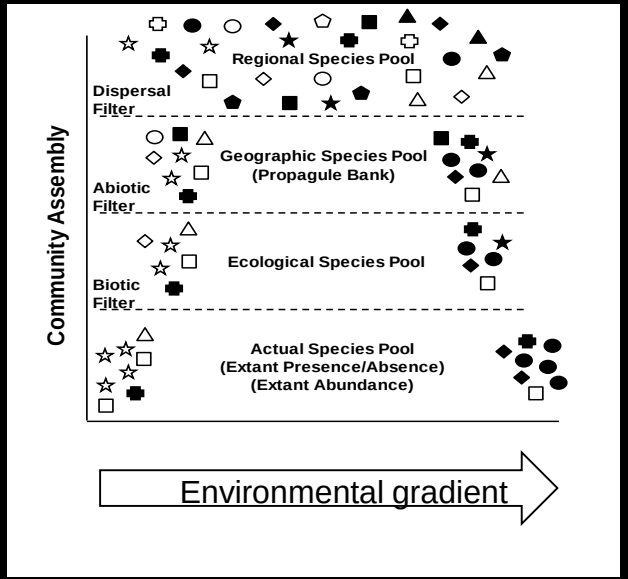
Implications for risk assessment & ecosystem management

2. Theoretical basis: a conceptual model

Community assembly theory

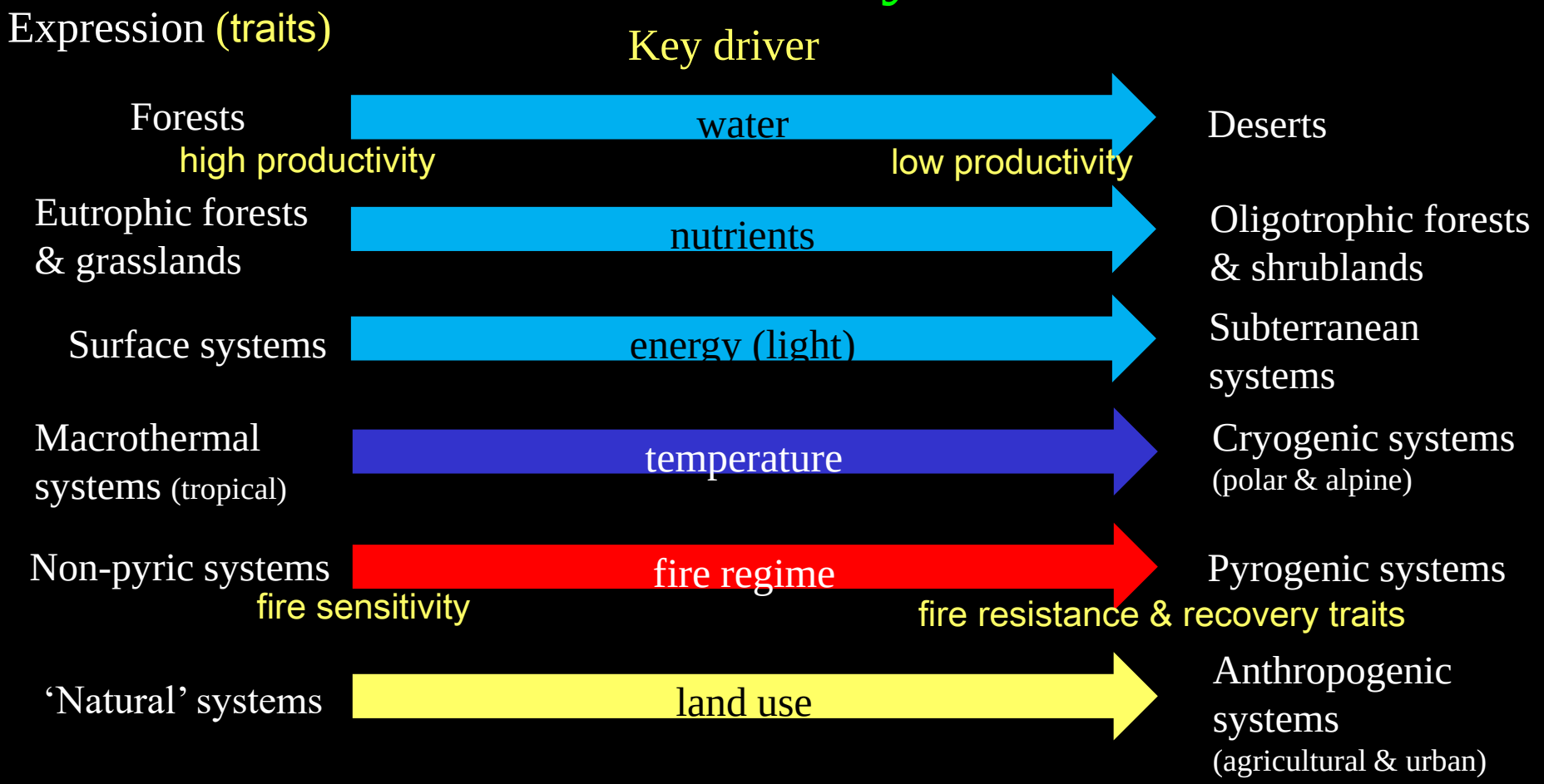
- A series of selection filters determine assemblages of biota (& traits) that co-exist (spatially & temporally)
- Filters may be grouped:

– dispersal;
– abiotic;
– biotic

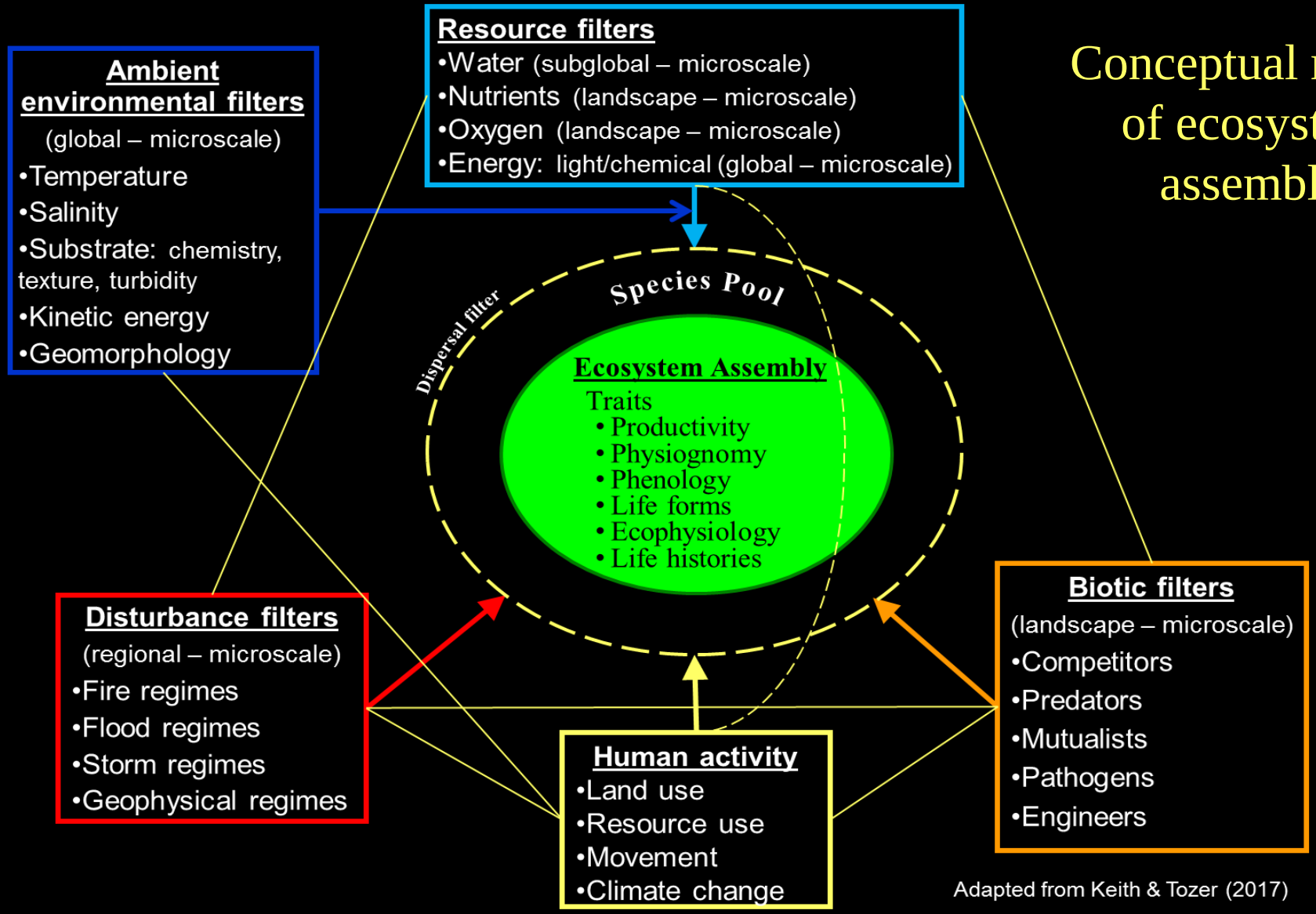


Dawson et al. (in press)

Macroenvironmental gradients in terrestrial ecosystems



Conceptual model of ecosystem assembly



Adapted from Keith & Tozer (2017)

3. Scalable structure (hierarchy)

Level	Definition
Realm	One of three component media within the biosphere: marine, inland aquatic, terrestrial
Sub-realm	A segment of the biosphere united by common macro-environmental features and key biotic traits within a realm
Functional ecotype	A group of related ecosystems within a subrealm that are structured by common ecological processes (ecosystem drivers), such that their responses may be represented by the same generic models of ecosystem dynamics.
Biogeographic functional ecotype	A regional biogeographic expression of a functional ecotype (delineated by an appropriate ecoregionalisation)
Ecosystem type	A complex of organisms and their associated physical environment within an area that serves as an operational unit of assessment for the global Red List of Ecosystems. Ecosystem types occur within Biogeographic functional ecotypes
Local ecosystem type	Any subunit or nested group of subunits within a global ecosystem type that serves as an operational unit for a subglobal (e.g. national) Red List of Ecosystems

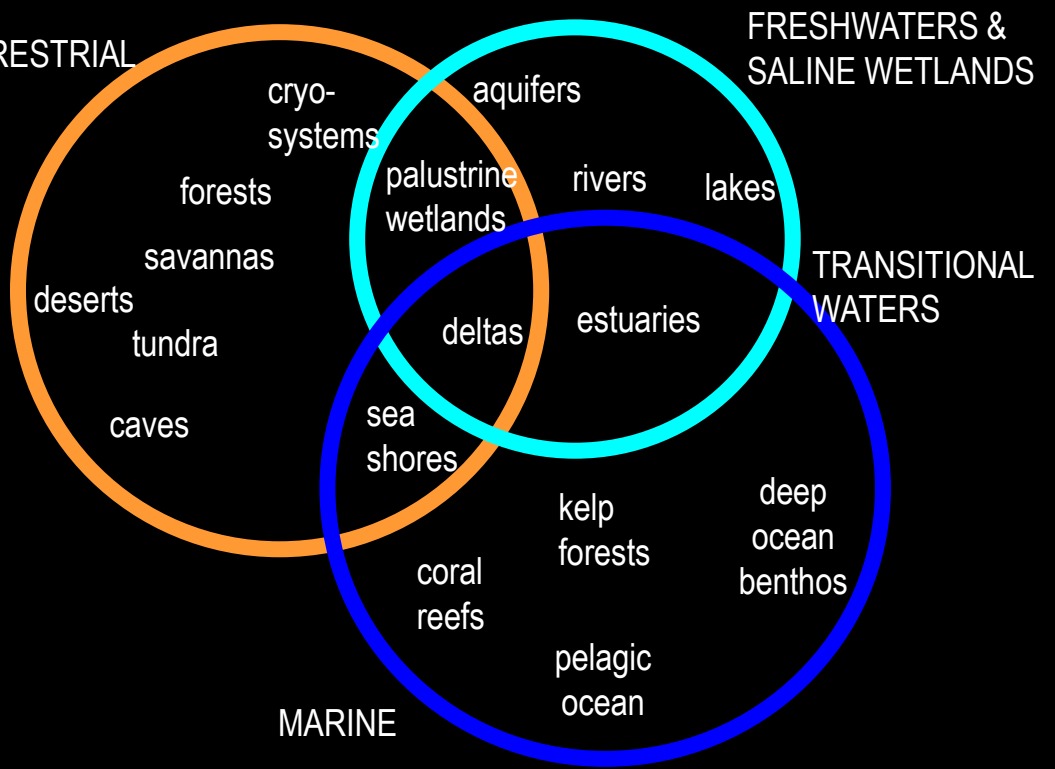
Functional features - Global guidance

Compos-itional features - Local expertise

3. Scalable structure (hierarchy)

Realms & subrealms

- Segregating 3 fundamental ecological systems
- top-down approach, essential for global consistency



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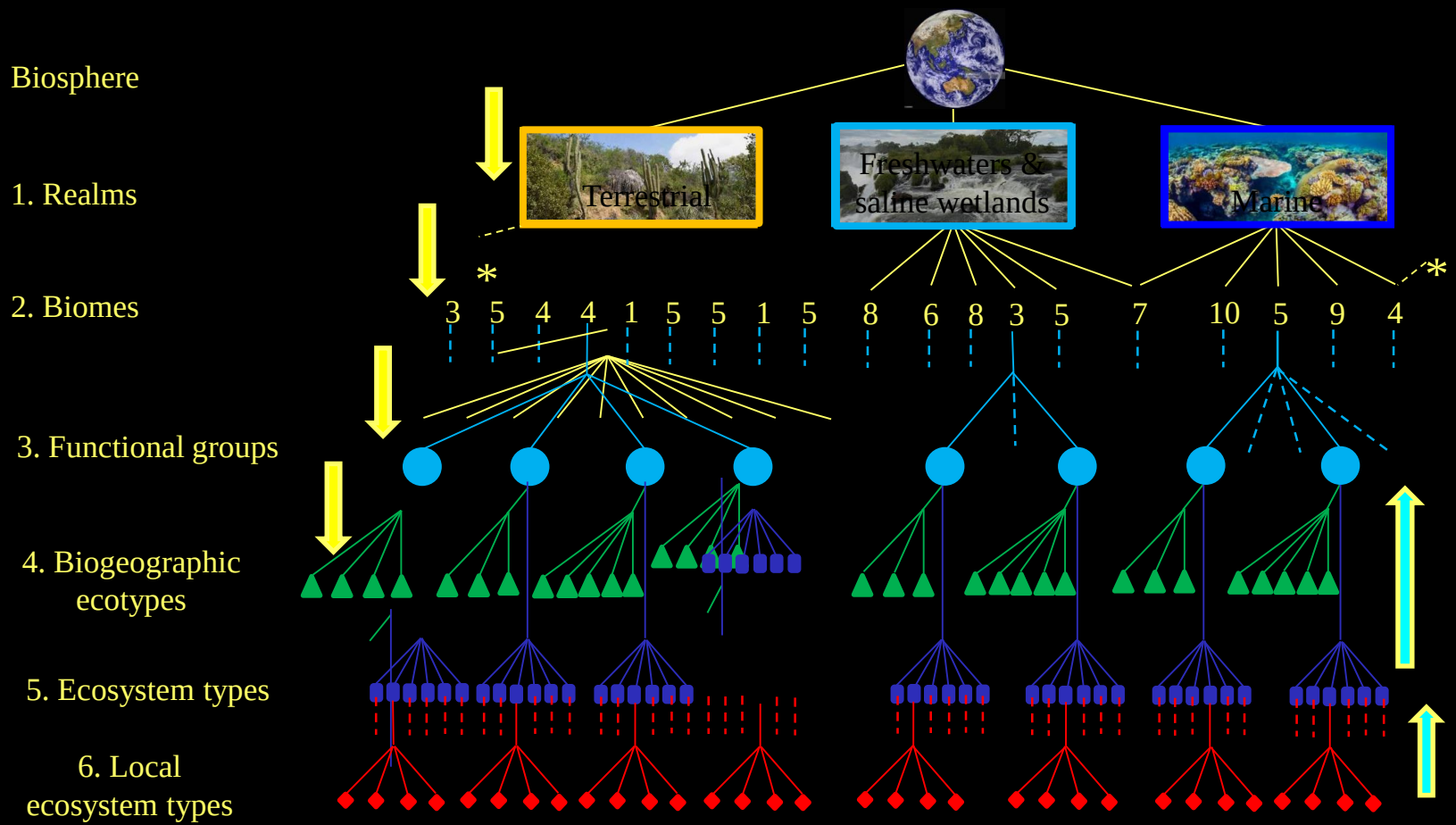

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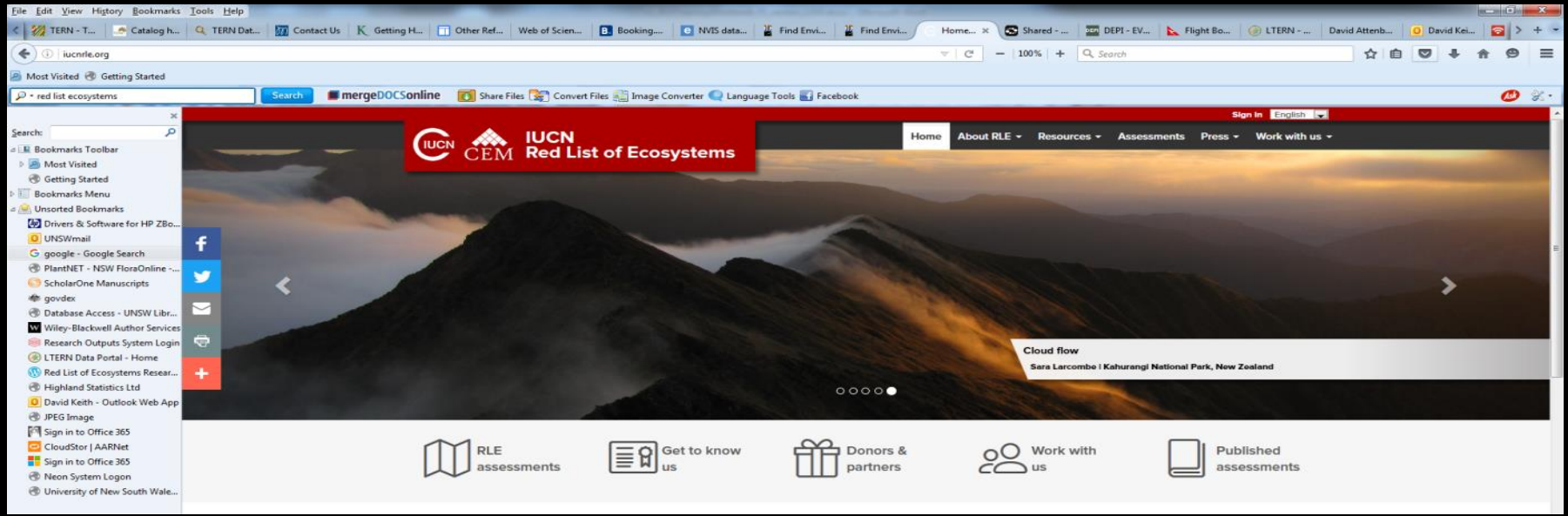
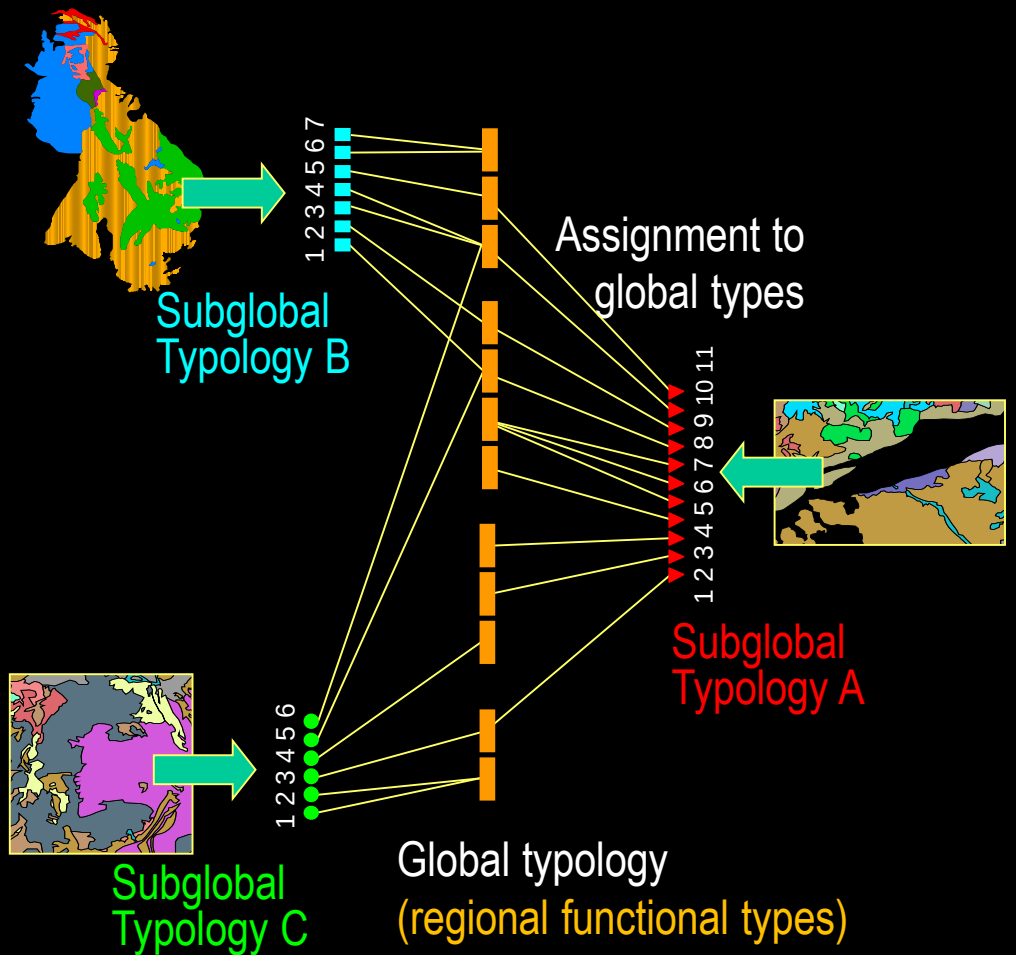


Thank you.

Translation between subglobal typologies



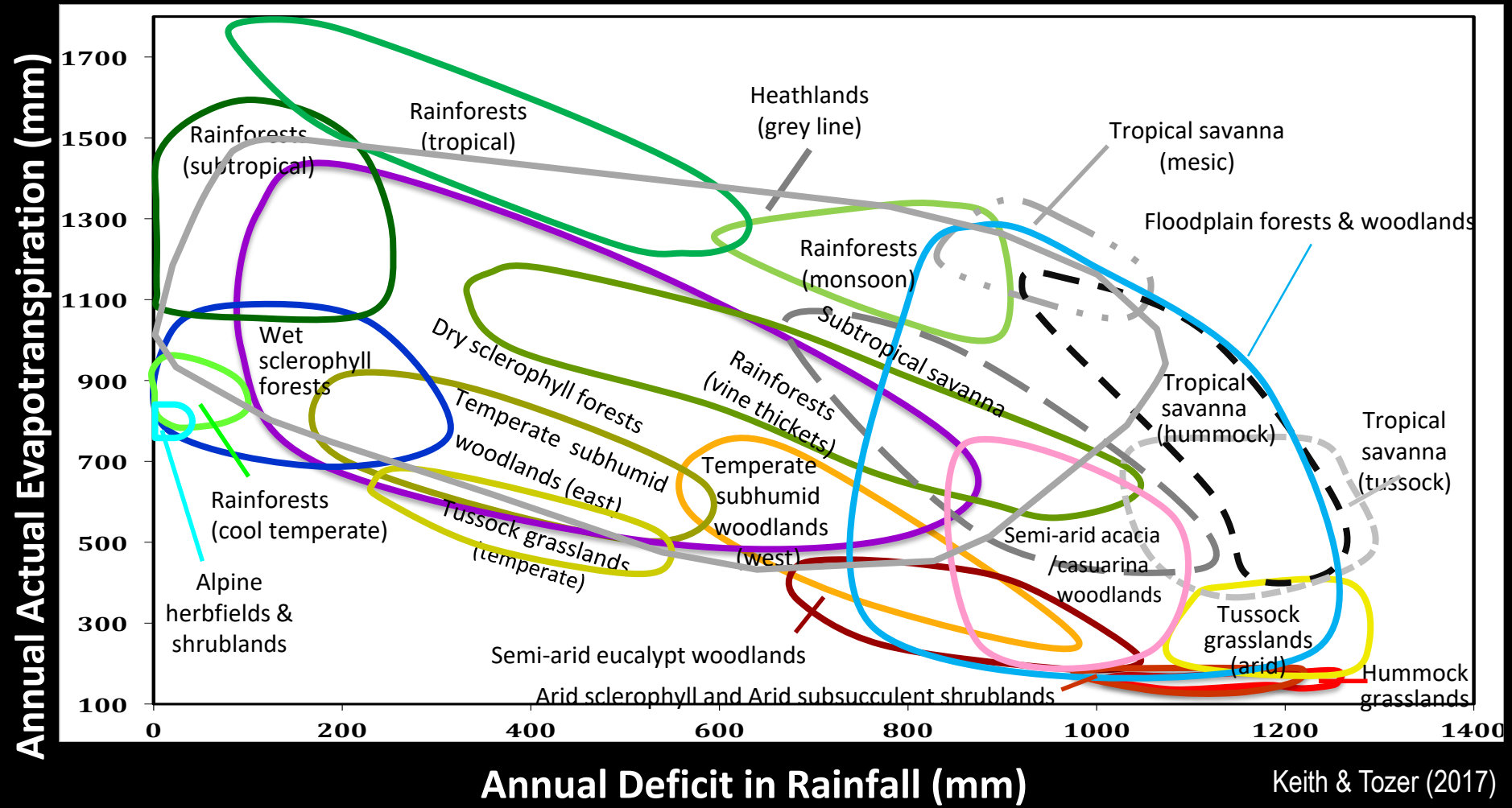
Typological framework

- Common language between multiple independent subglobal ecosystem classifications

Assignment to global types

- Quantitative methods (e.g. fuzzy clustering)
- Structured elicitation (attribute matching)

Environmental gradients



Keith & Tozer (2017)

Lessons from gradient analysis

Observation	Example	Implication for risk assessment
Ecosystems with similar structural forms may occupy functionally contrasting environments	Rainforests, savanna, grasslands	Structural attributes not always good proxy for function
Ecosystems with restricted geographic ranges may have large environmental envelopes for some resources	Heathlands – water cf. nutrients	May be resilient to climate change but not eutrophication
Ecosystems with large geographic ranges may have small environmental envelopes for some resources	Arid shrublands & Hummock grasslands	May be sensitive to climate change across large areas

- Gradient analysis reveals importance of considering *ecological processes* (e.g. resource filters) in ecosystem typologies for risk assessment
- Gradient analysis informs ecosystem typologies about entire environmental space across the domain of interest