

Gypsum ecosystems in Africa: Past and present research, and knowledge gaps

Stefan Siebert

North-West University, South Africa



- Africa is characterized by diverse geology.
- Gypsum is widespread in Africa – dates back to the Cretaceous (Martin 1963).
- Numerous edaphic centres of plant endemism and biodiversity hotspots (Lovett & Friis 1996; Van Wyk & Smith 2006).



Randonia africana



Teloschistes capensis



Fagonia latifolia



Arthraerua leubnitziae



Commiphora guidottii



Euphorbia columnaris



Dorstenia gypsophila

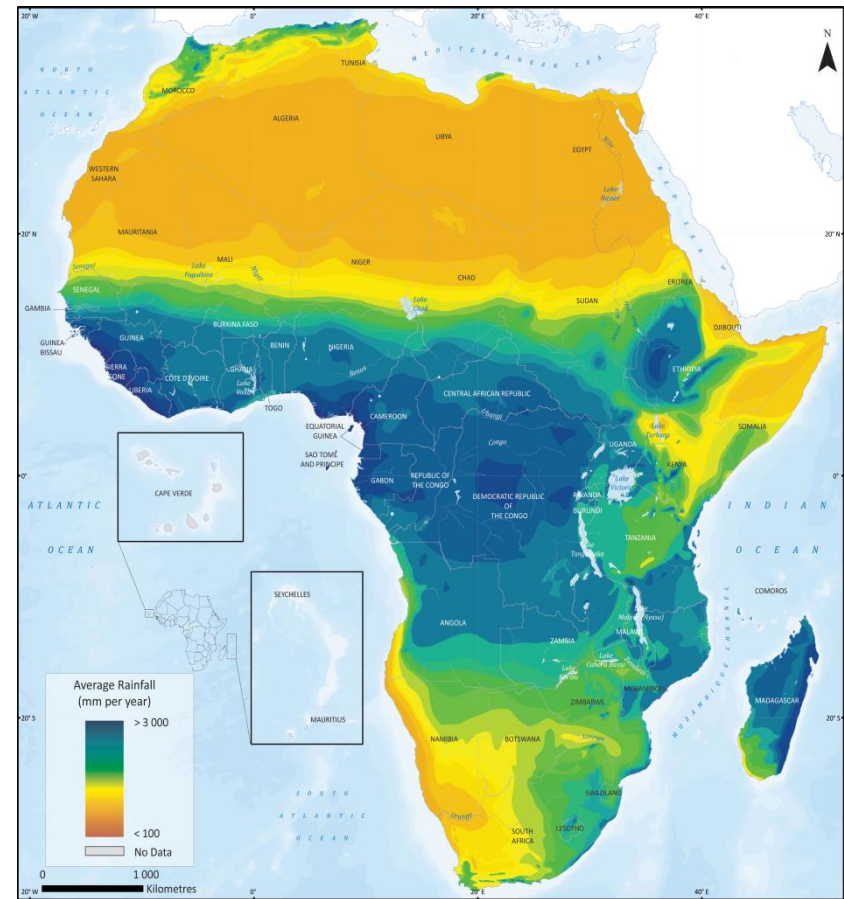


Henophyton deserti





Adapted from Pérez-García *et al.* (2017); Plant Sociology, 54(2), 61-76.



Taken from Africa Water Atlas



‘Gypsum areas carry a characteristic flora, but very little is known about just which species are obligate gypsophiles. About all that can be said is that the unique gypsum flora contains a number of undescribed species’ (Parsons **1976**)



‘Gypsum floras remain much more poorly studied compared to other important edaphic endemic communities’ (Moore *et al.* **2014**)



Aim

To assess the African literature on gypsum ecosystems to evaluate the extent and knowledge base on the continent.



Key questions

1. In which regions of Africa is research on gypsum ecosystems purposefully pursued?
2. What are the major research themes on the continent?
3. What do we know regarding gypsophytes?

Review approach

- Systematic, non-bias approach
- Keyword selection in SCOPUS
 - gyps*
 - AND africa*
 - AND plant* OR vegetation OR flor*
- Output result: 24 papers for screening
- Only 15 of relevance



Review approach

- Keyword selection in GOOGLE SCHOLAR
 - gyps [**gypsum**; **gypsaceous**; **gypsophilous**]
 - africa
 - plant vegetation flora
- Sorted for relevance
- Output result: first **80** papers for screening



Inclusion criteria

1. Ecosystem must be located on gypsum (CaSO_4).
2. Research site must be located in Africa or Madagascar.
3. Study must focus on photoautotrophs.



Exclusion criteria

1. Studies dealing with agricultural applications.
2. Any other language than English – my shortcoming!
3. A soil science focus only.

53 papers



(1) Extracting key metrics to characterize literature:

- (1) origin of study (country and region)
- (2) specific gypsum area
- (3) date of publication
- (4) countries involved in research
- (5) life forms

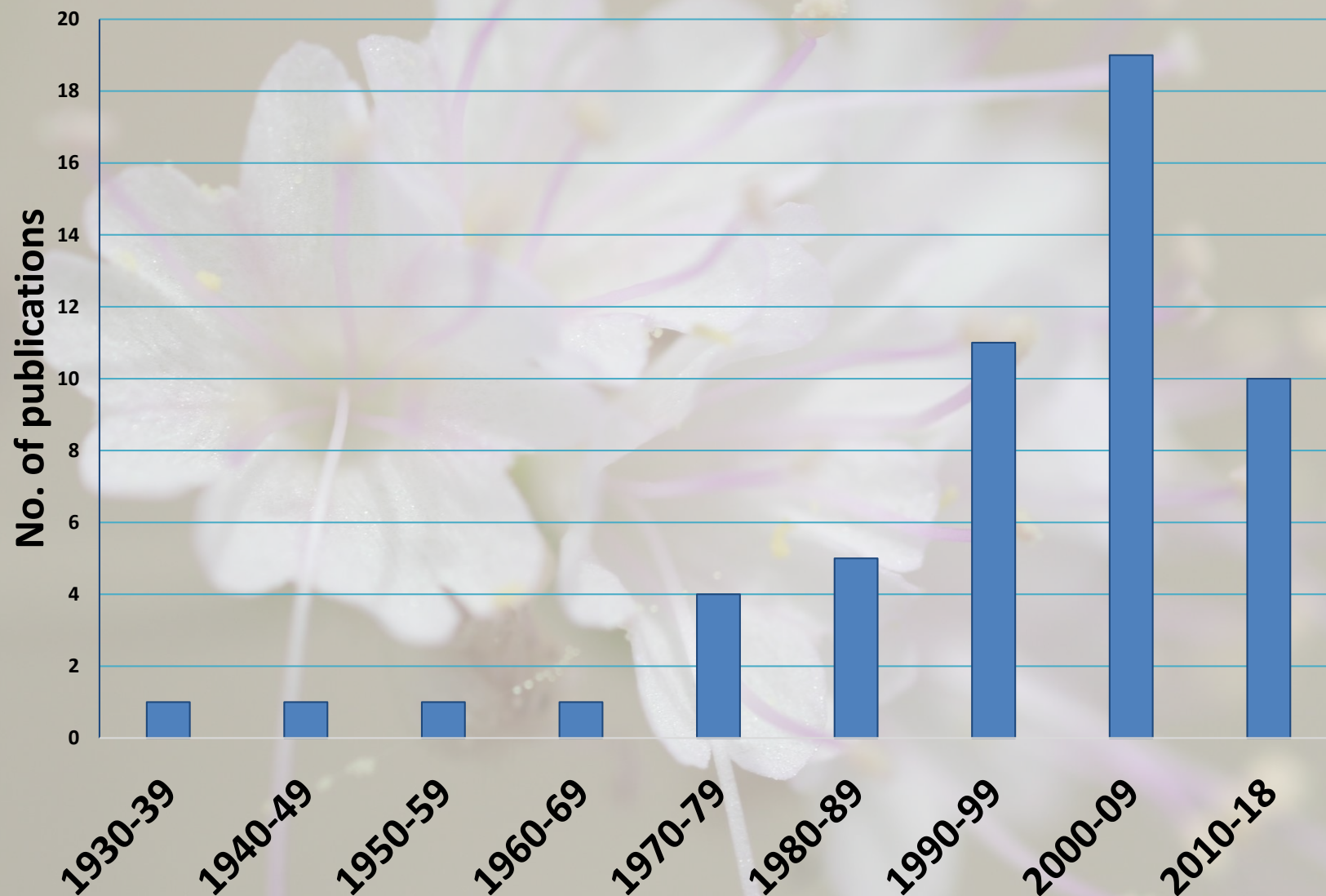
(2) Defining the overall research context:

- (1) field of study
- (2) research aims
- (3) overarching research theme

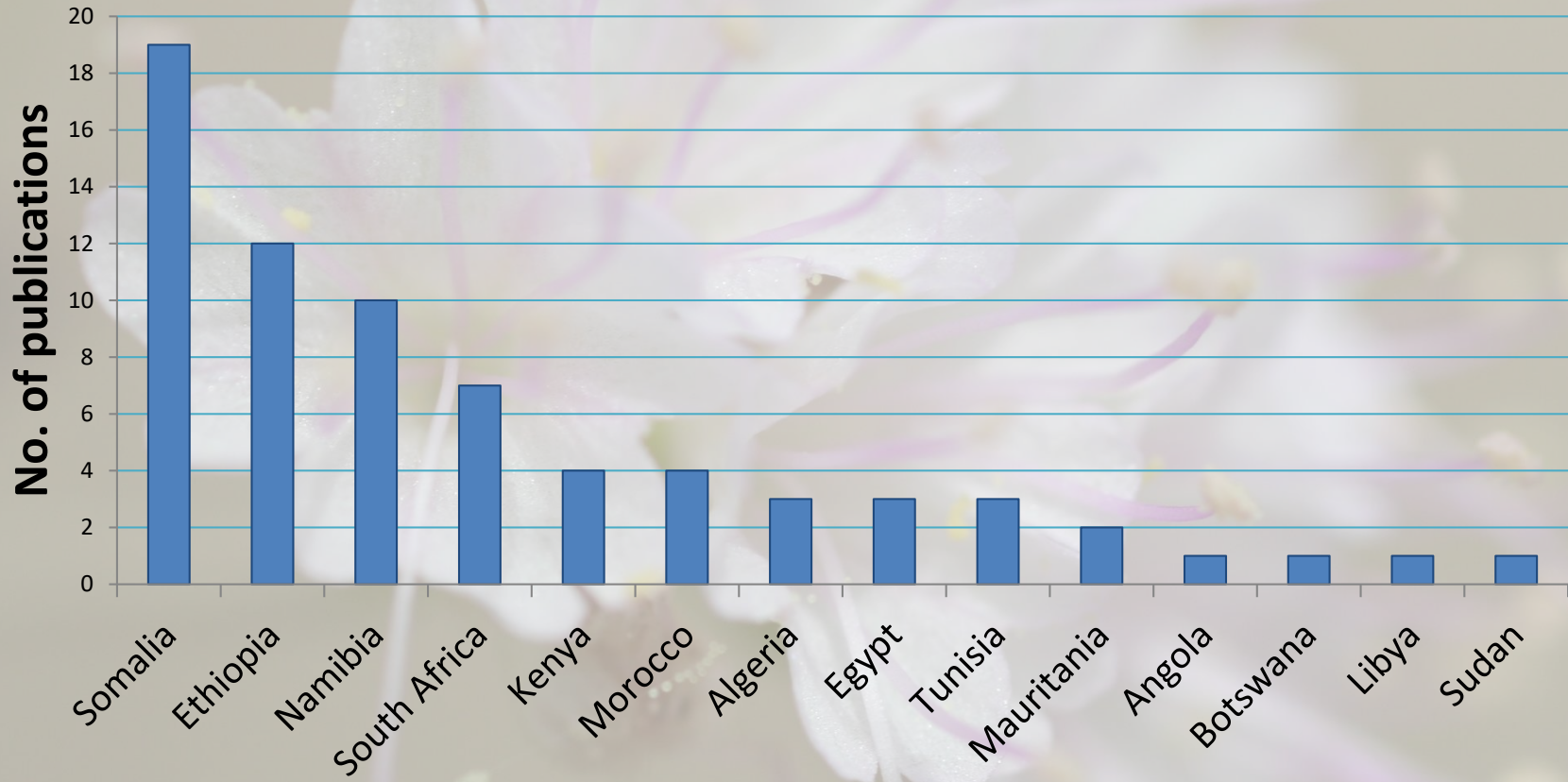
(3) Synthesis of core findings per research theme and identification of knowledge gaps.



Metrics: Chronology



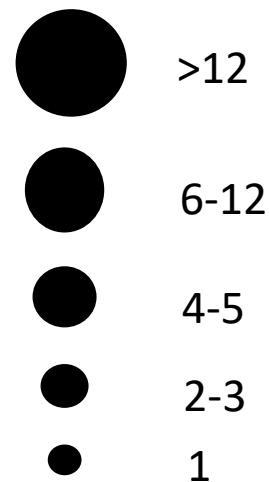
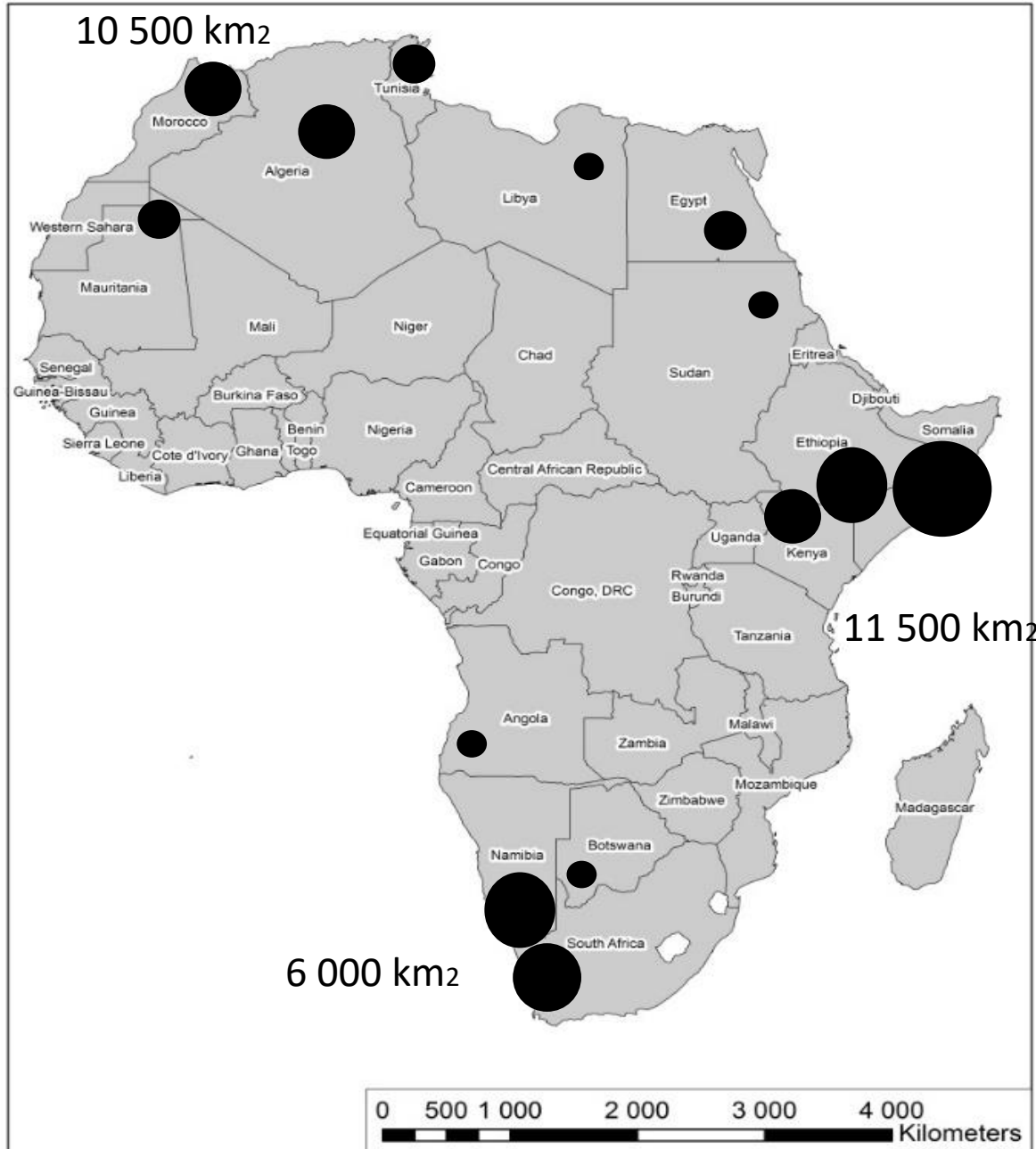
Metrics: Countries





Africa

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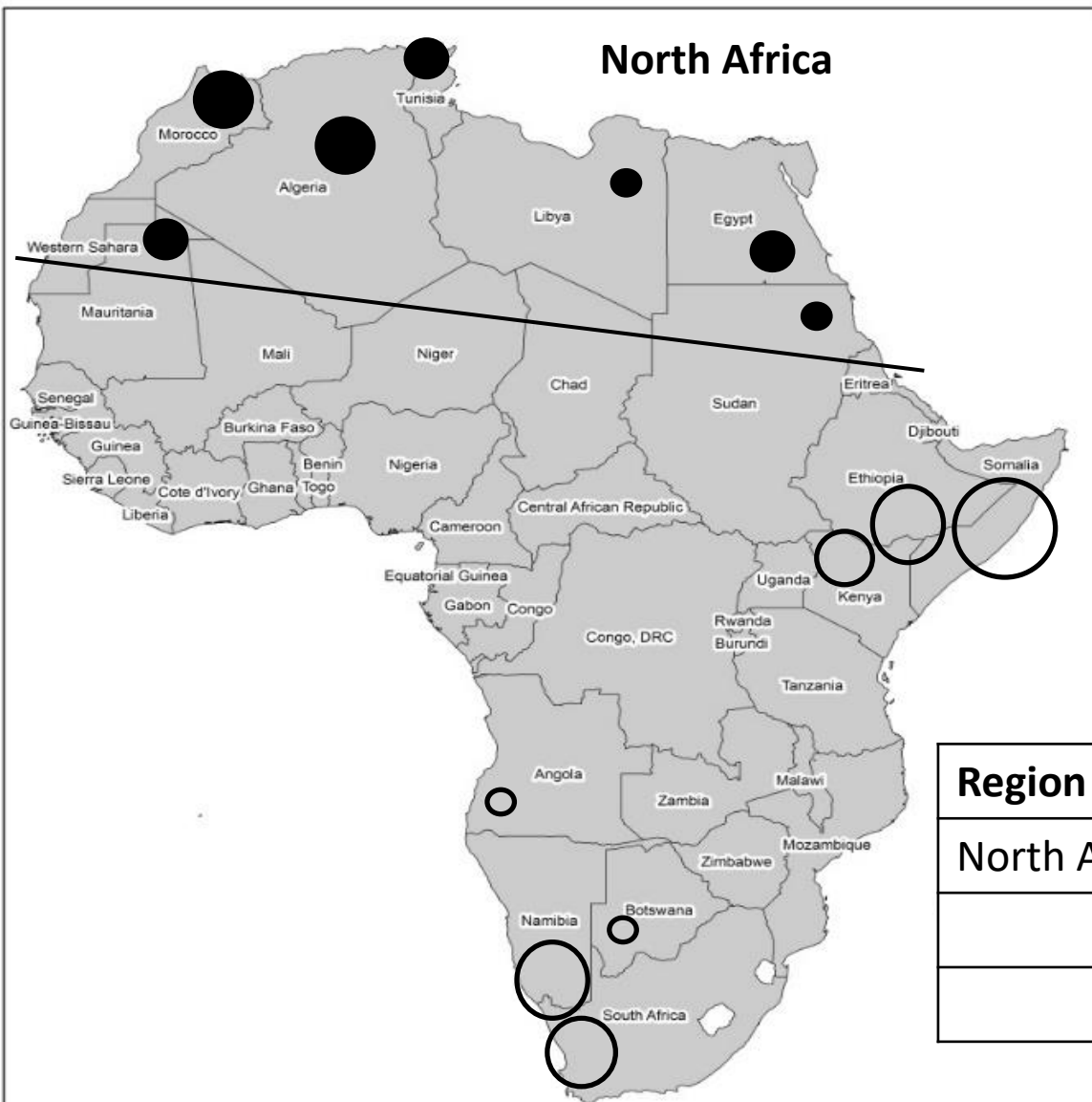
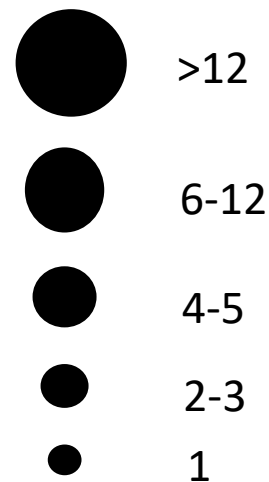




Africa

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North Africa



Region

Papers

North Africa

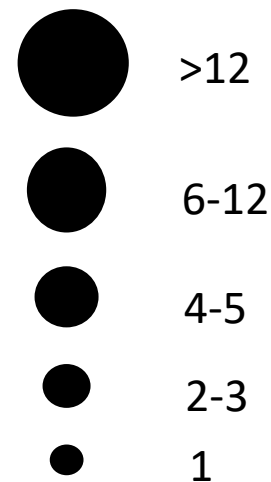
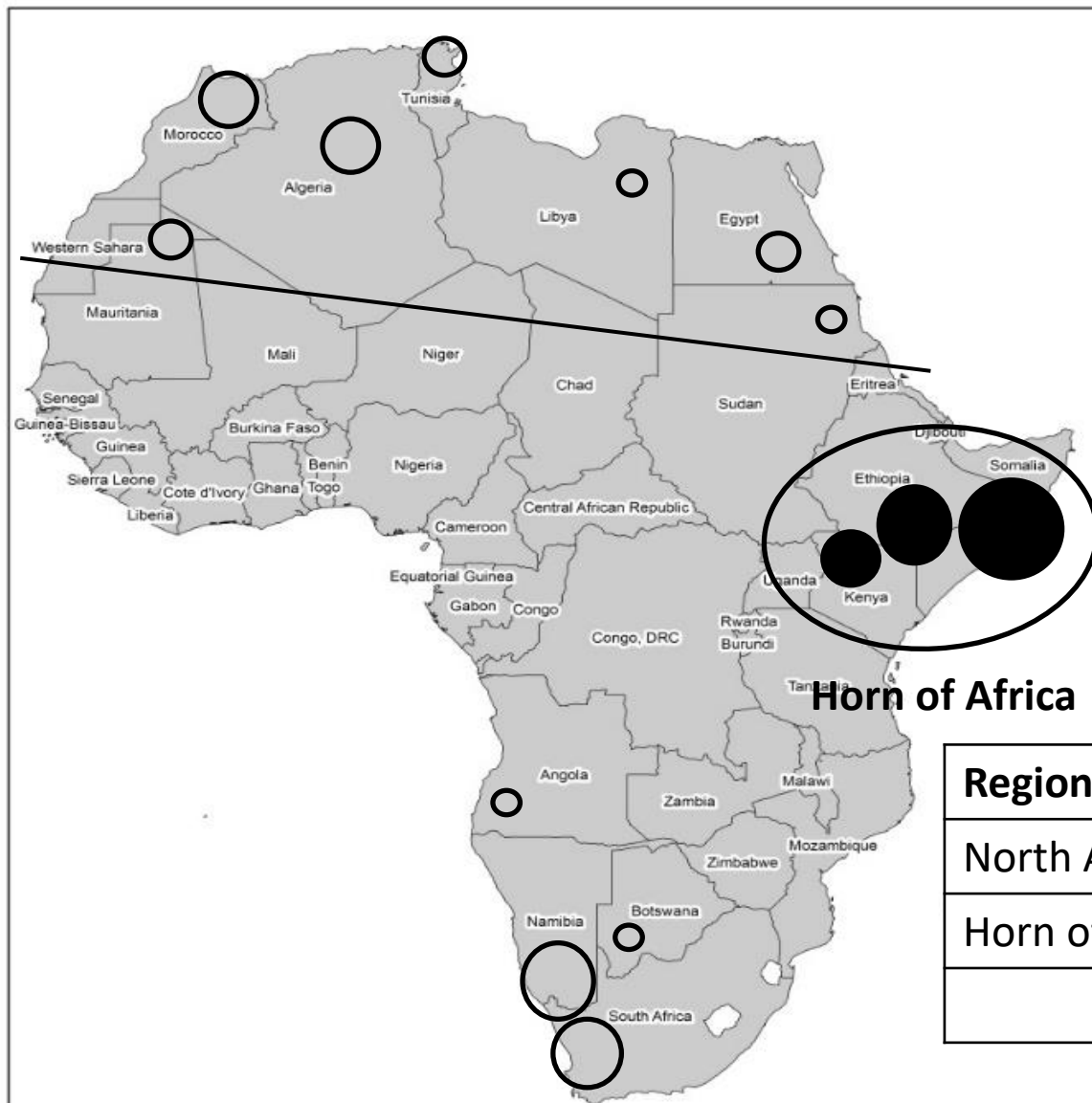
24% (14)

0 500 1 000 2 000 3 000 4 000 Kilometers



Africa

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Horn of Africa

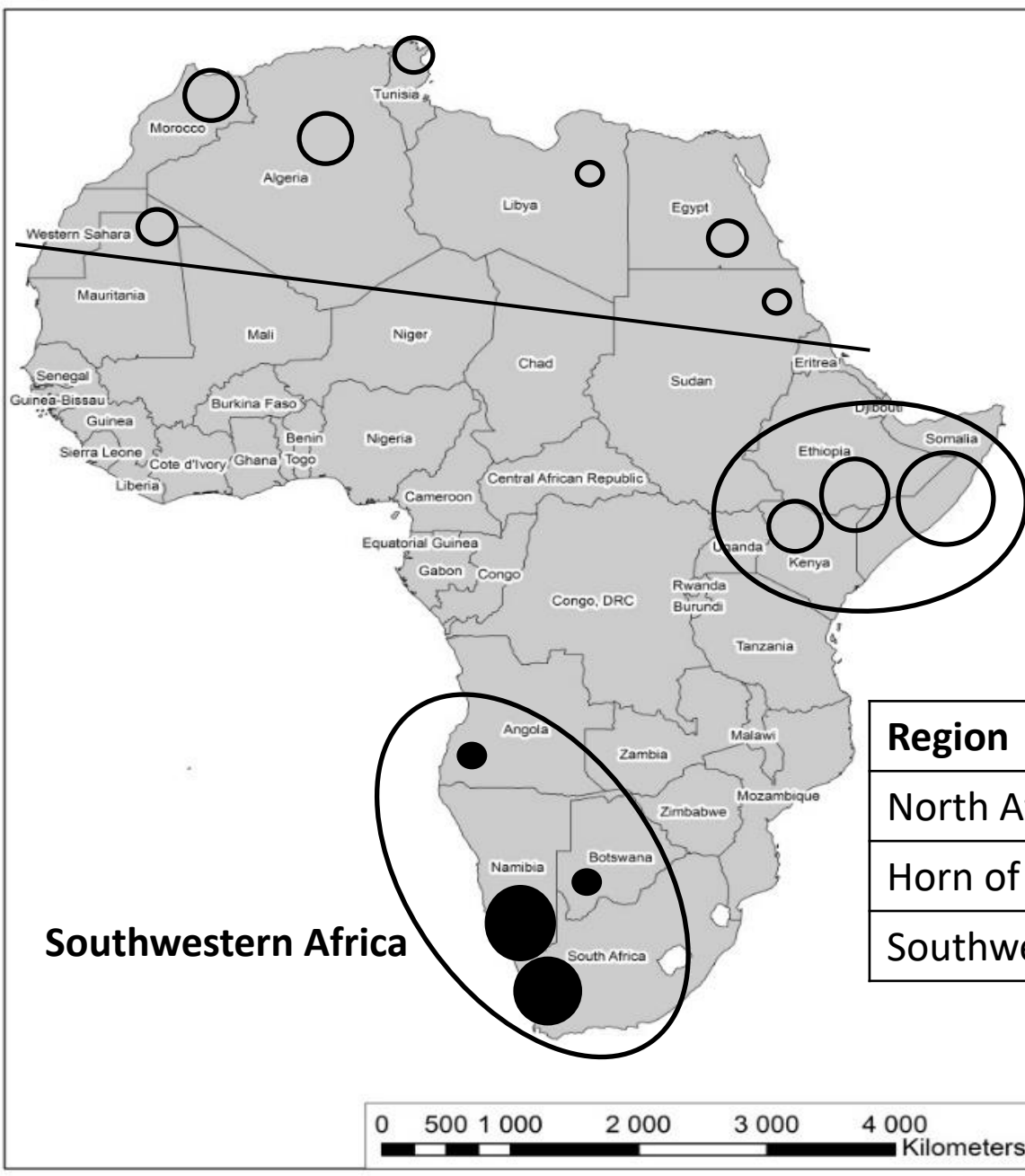
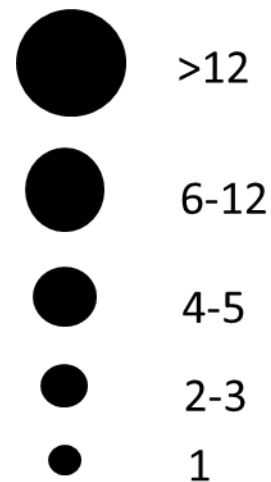
Region	Papers
North Africa	24% (14)
Horn of Africa	46% (26)

0 500 1 000 2 000 3 000 4 000 Kilometers



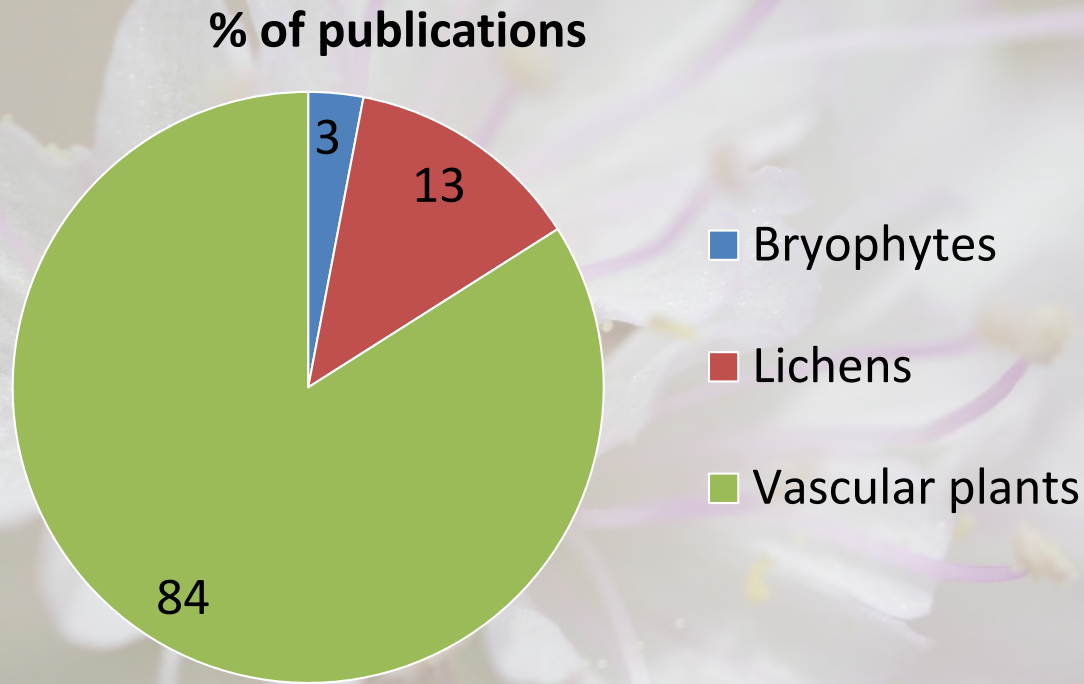
Africa

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Region	Papers
North Africa	24% (14)
Horn of Africa	46% (26)
Southwestern Africa	30% (17)

Metrics: Main groups

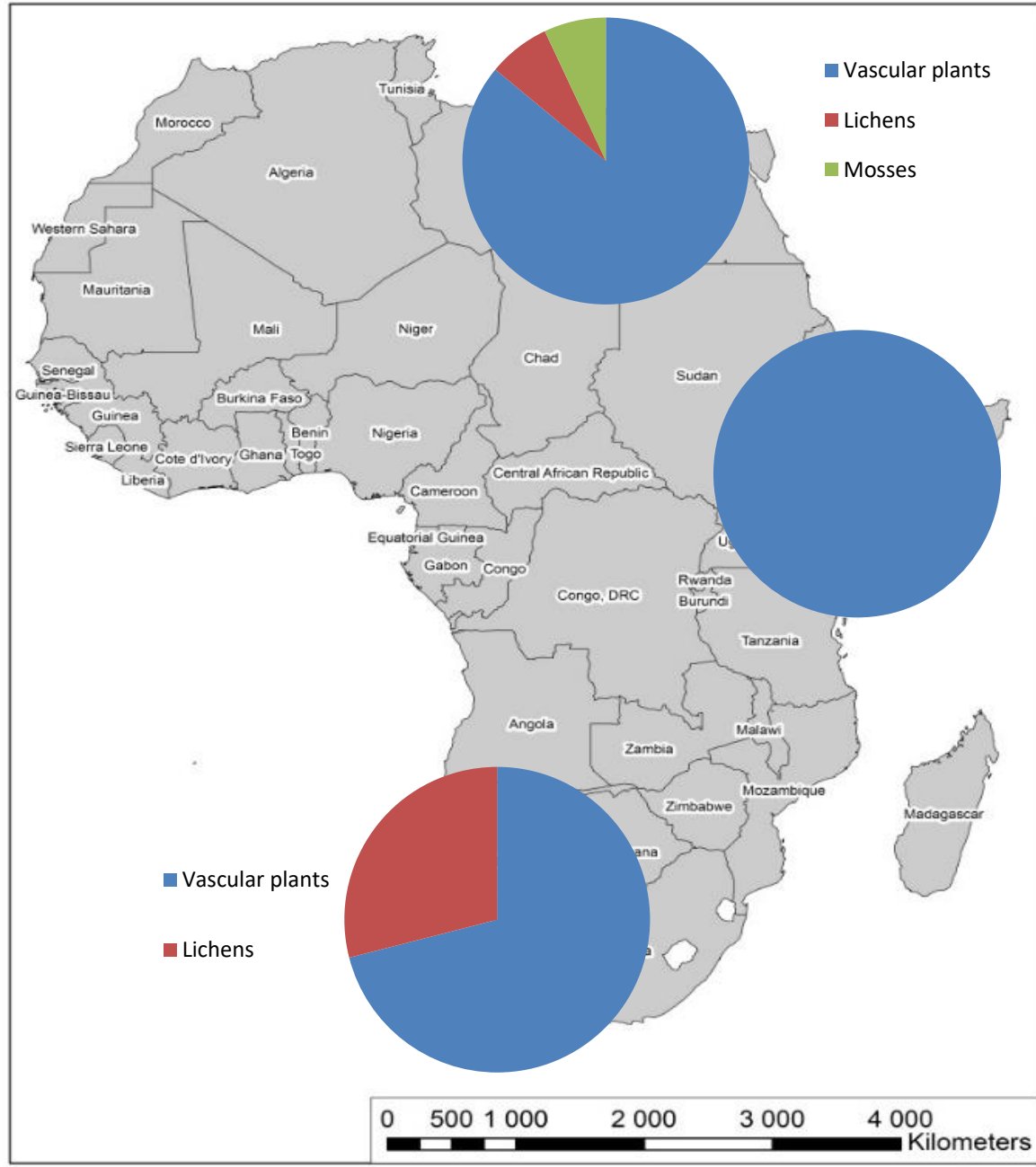


- main focus on vascular plants
- differs between the three regions

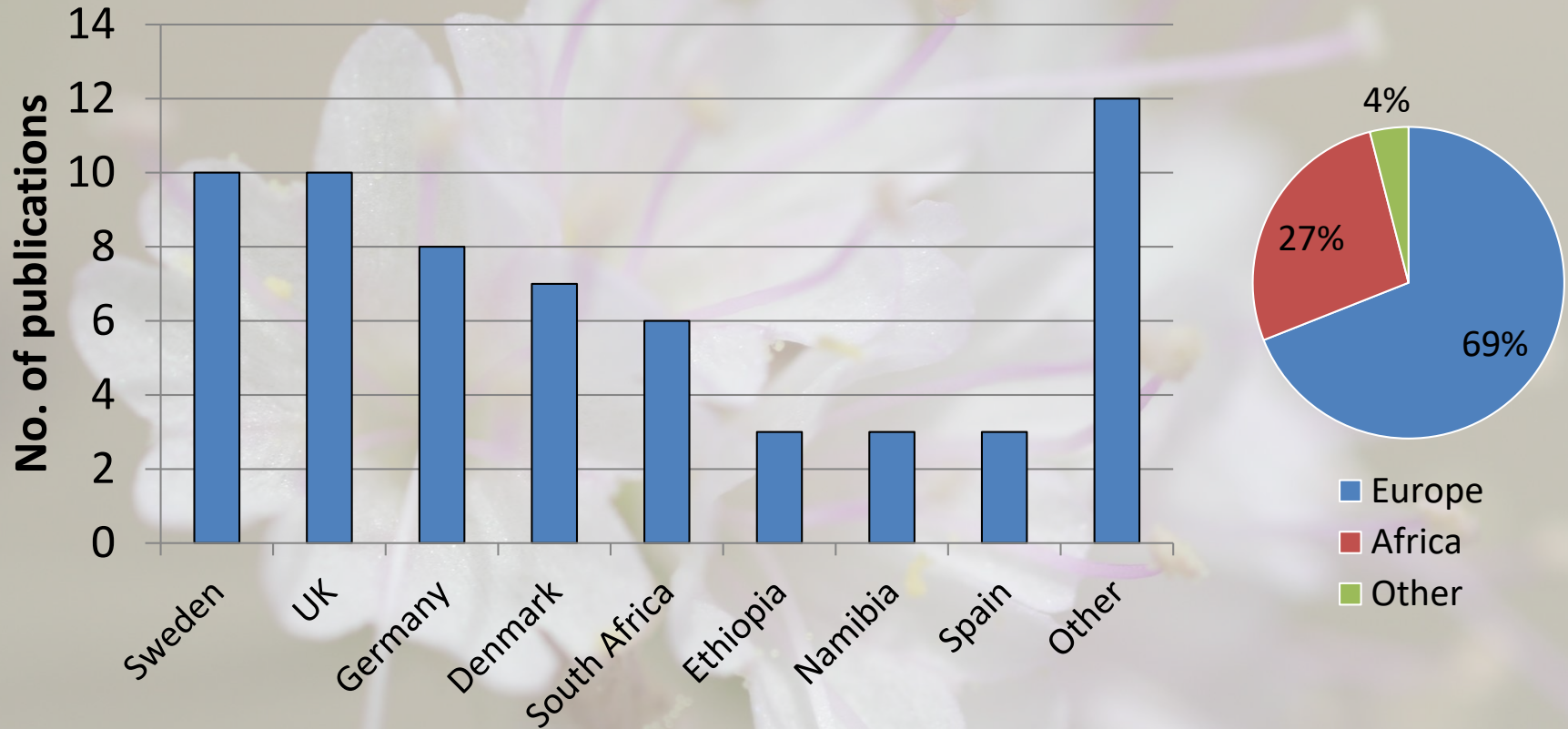


Africa

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Metrics: Authors

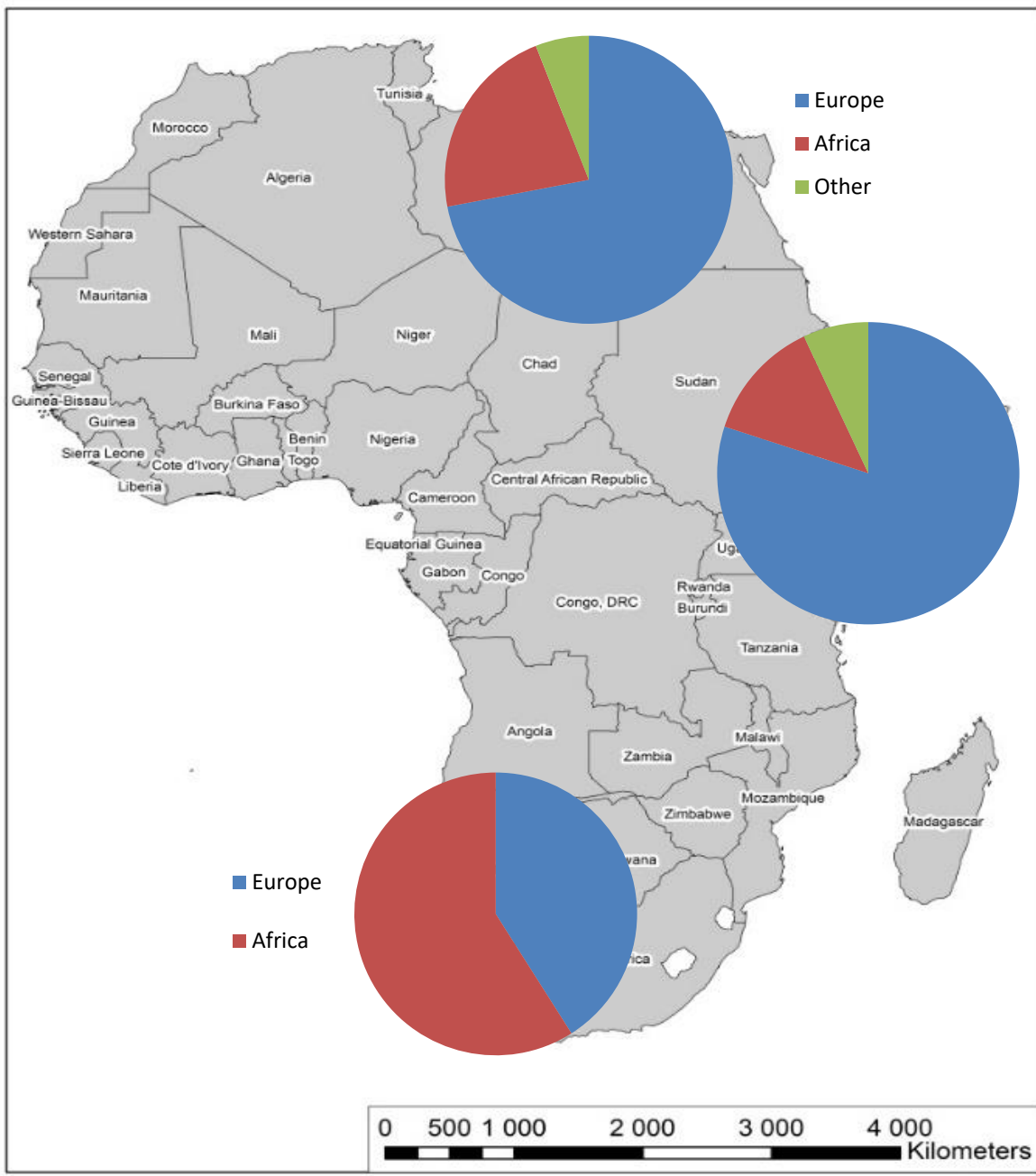


- European researchers contribute the most
- differs between the three regions

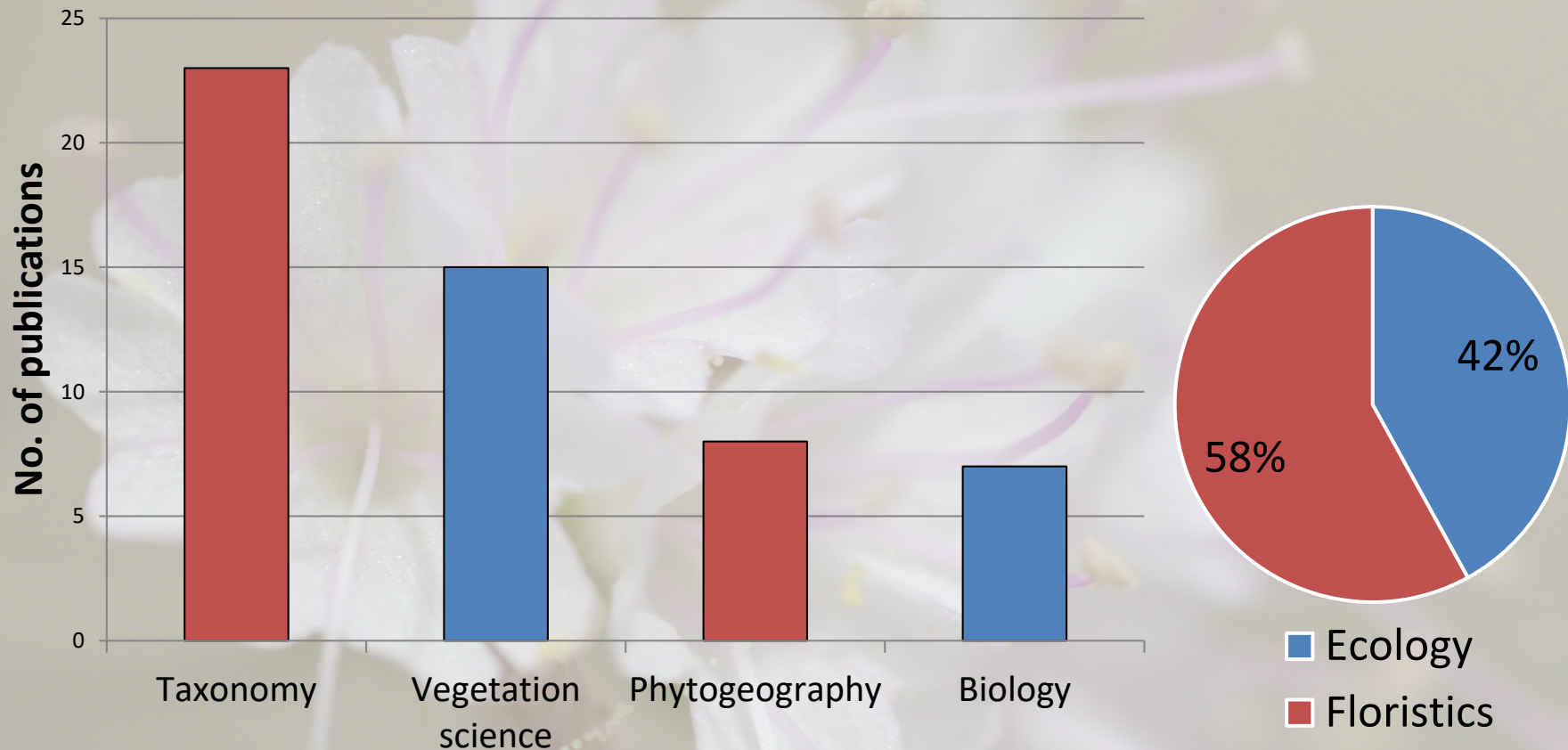


Africa

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Metrics: Research fields

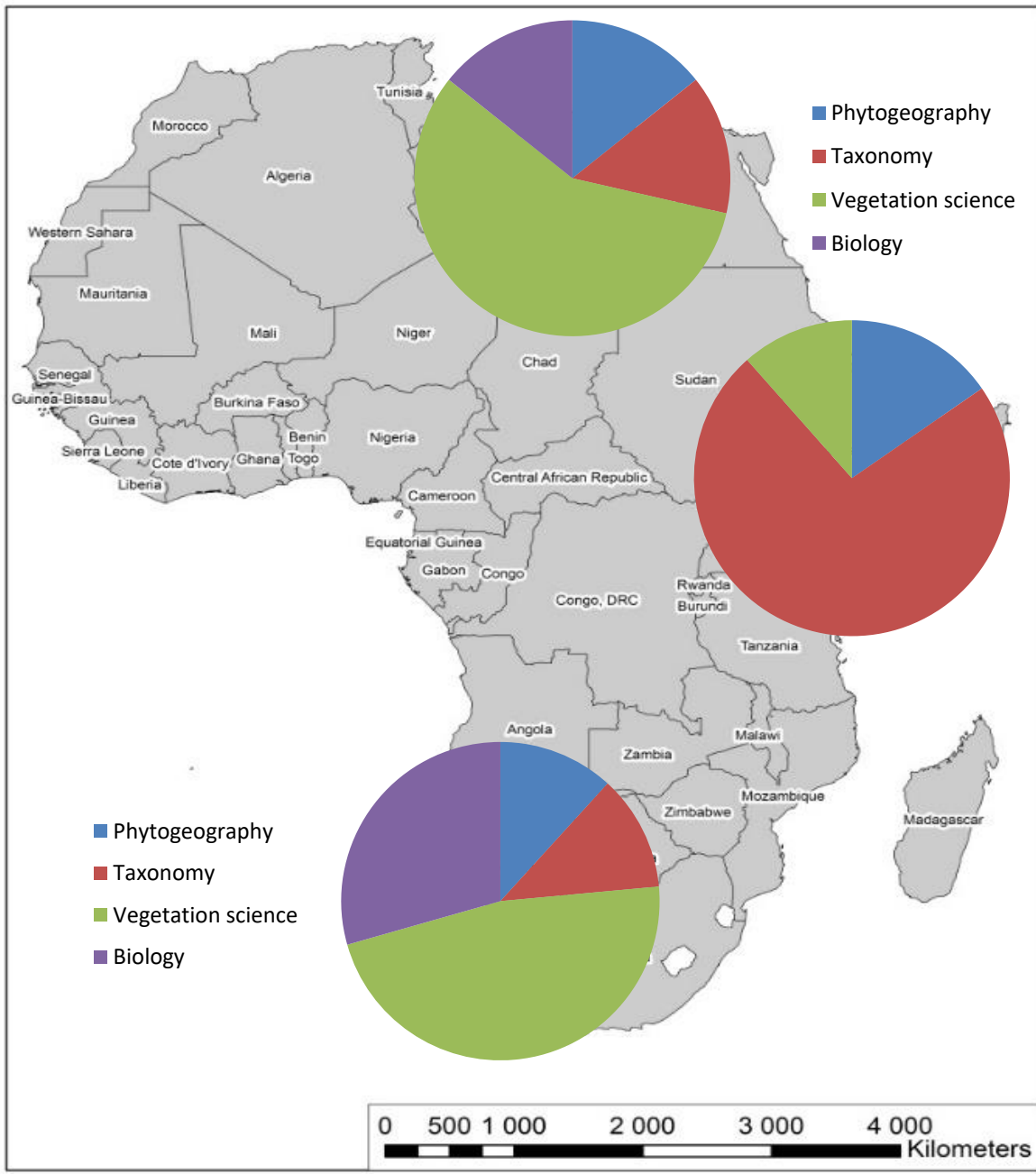


- Taxonomy has dominated research on gypsum
- differs between the three regions



Africa

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Preliminary list of 164 species (53 publications)

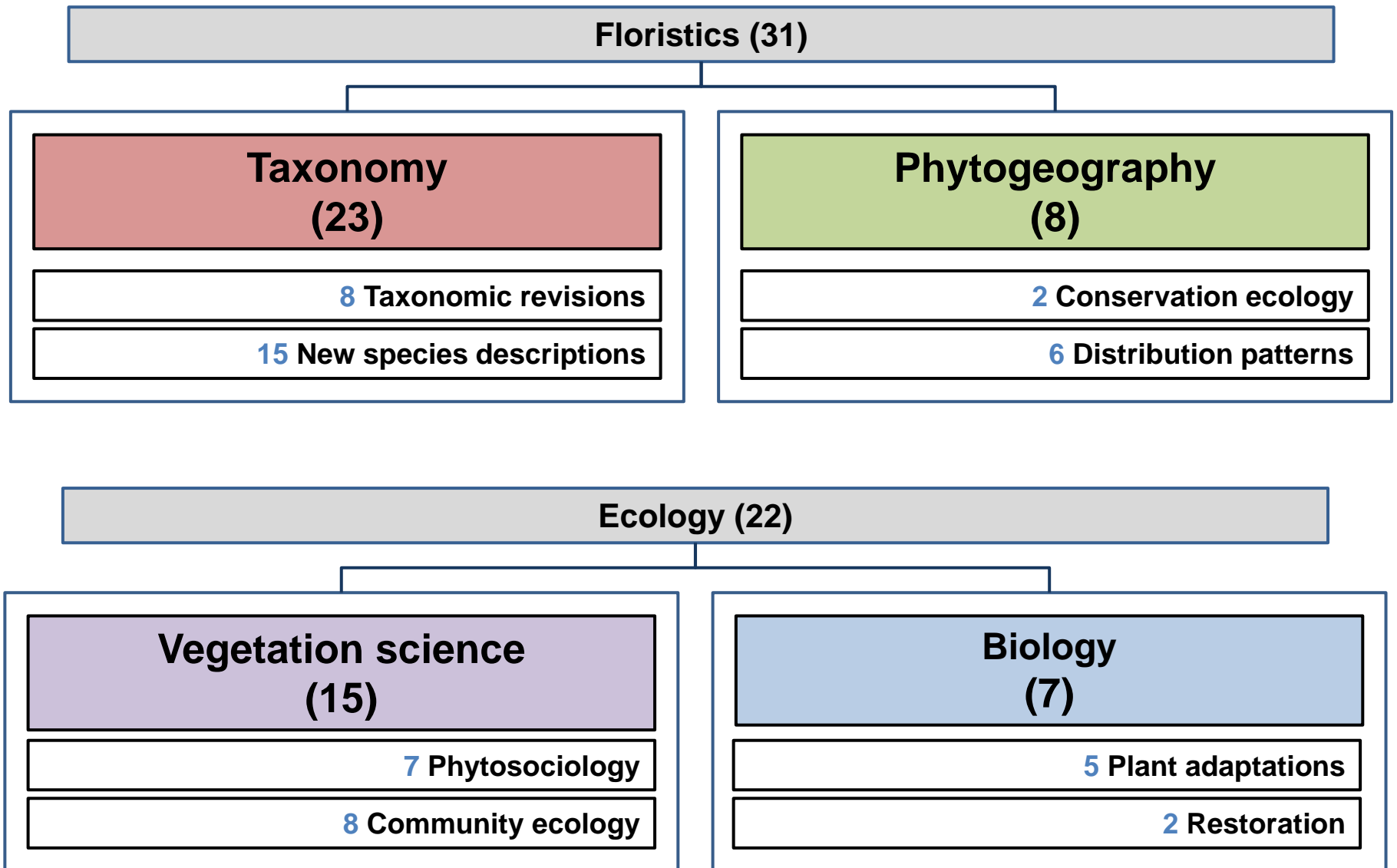
Gypsovags and gypsophytes

Genera	%
<i>Euphorbia</i>	10
<i>Stipagrostis</i>	4
<i>Tetraena</i>	4
<i>Aloe</i>	3
<i>Commiphora</i>	3
<i>Kleinia</i>	3

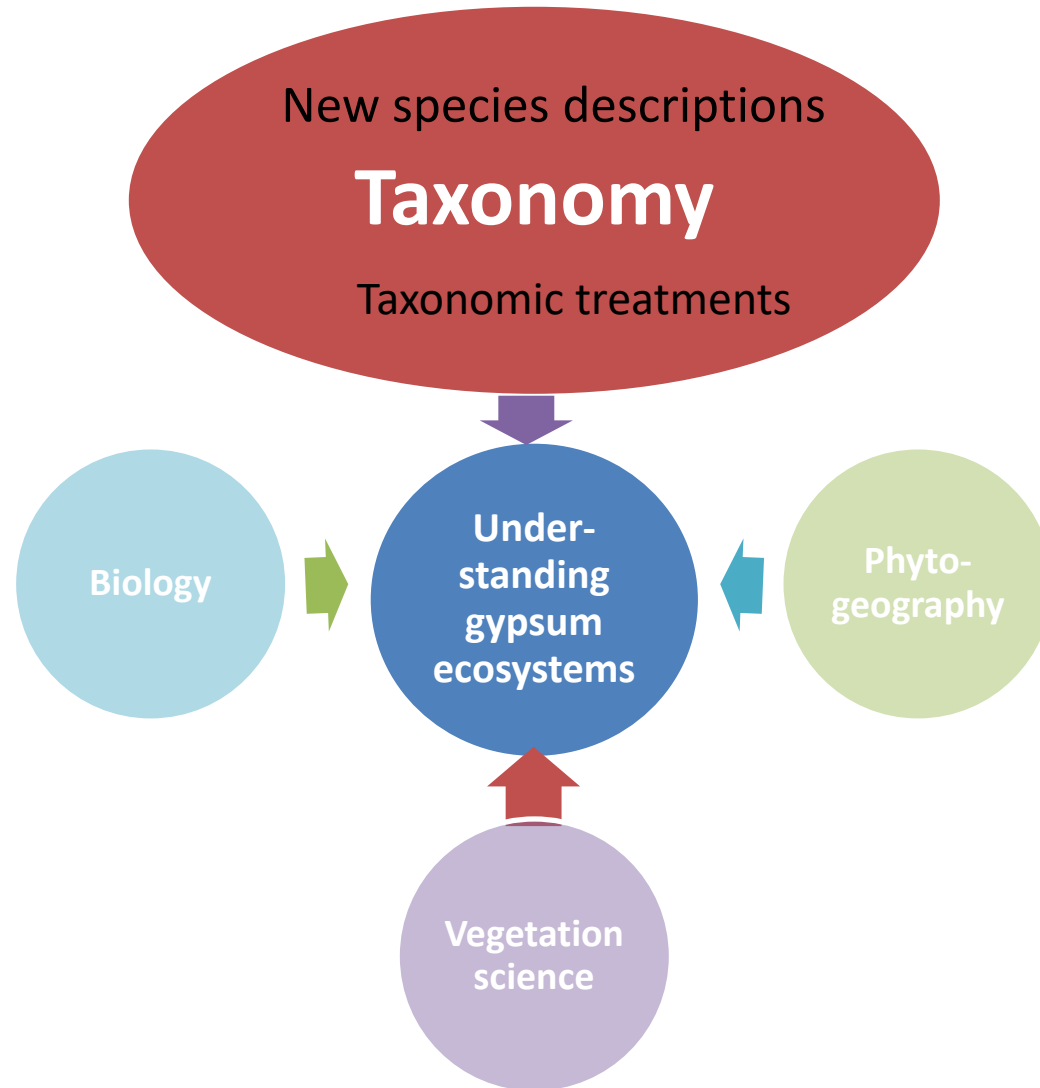
Families	%
Euphorbiaceae	18
Aizoaceae	16
Amaranthaceae	15
Poaceae	15
Zygophyllaceae	11
All lichen families	10



Ranking of overarching themes:

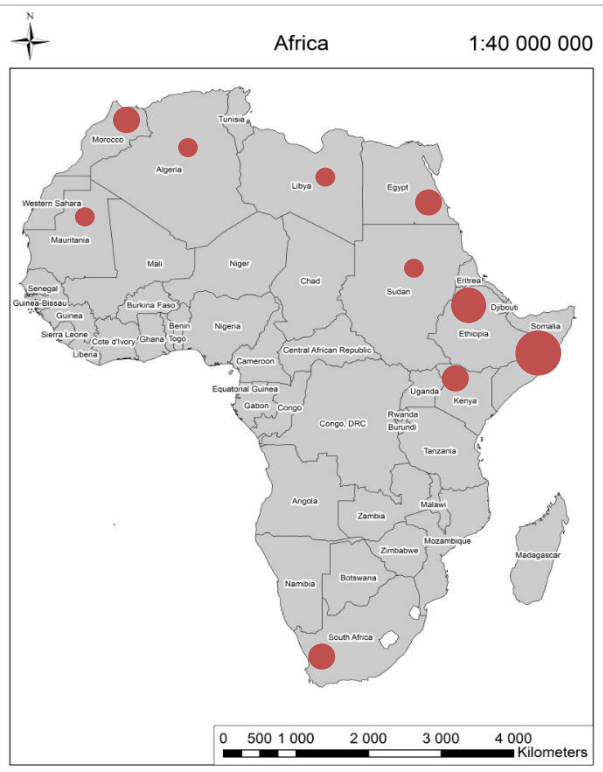


Some core findings:

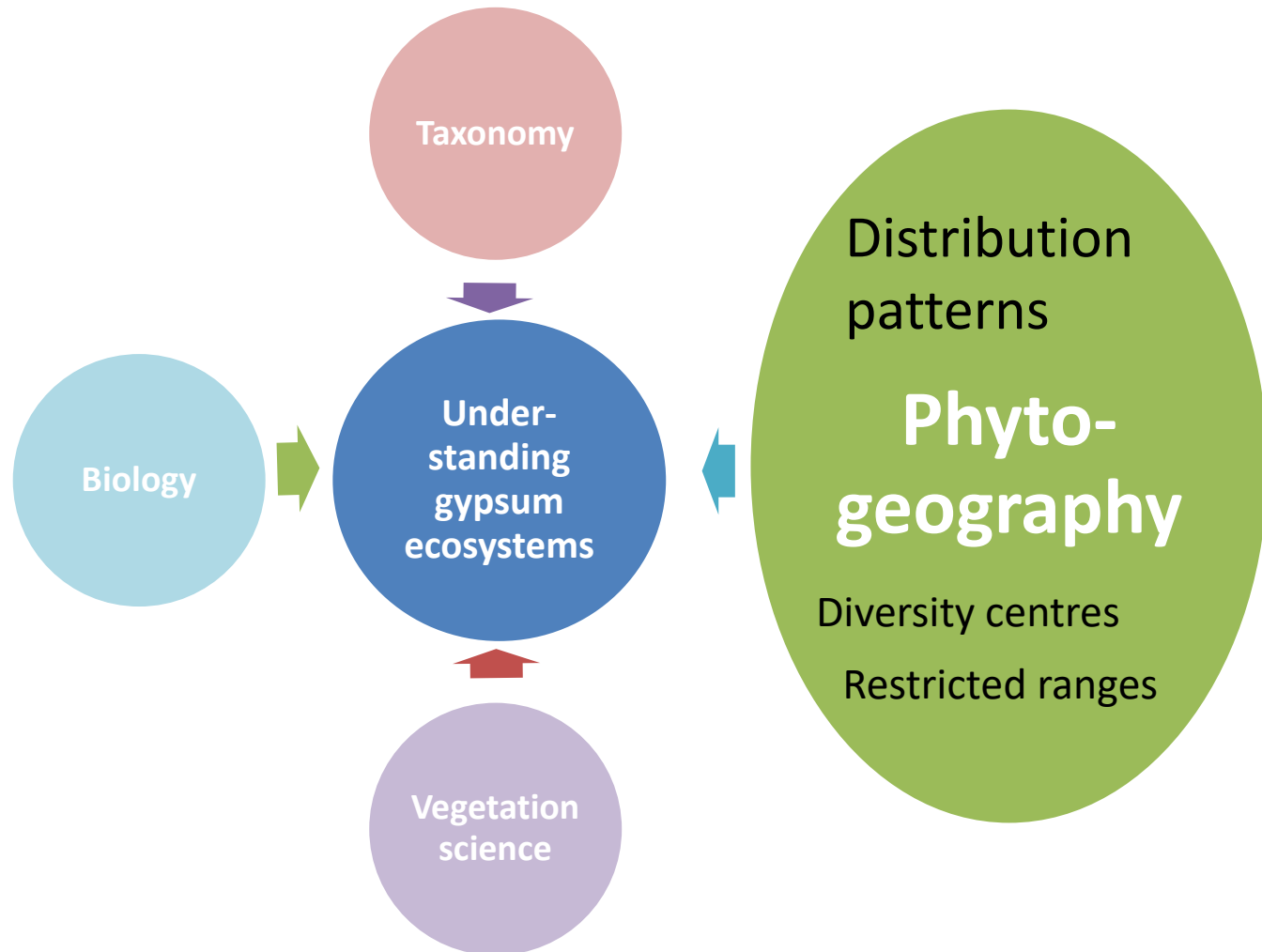


Taxonomy

- Over the years many new species have been discovered on gypsum soils (Boulos *et al.* 1991; Beier 2001).
- Some families seem to adapt and diversify on gypsum (Hadidi 1985; Friis *et al.* 1991).
- Taxonomic revisions provide information on gypsophytes (Philips & Launert 1971; Demissew 2001).
- Gypsophily also present in lichens (Casares-Porcel *et al.* 1996; Schieferstein & Loris 1992).

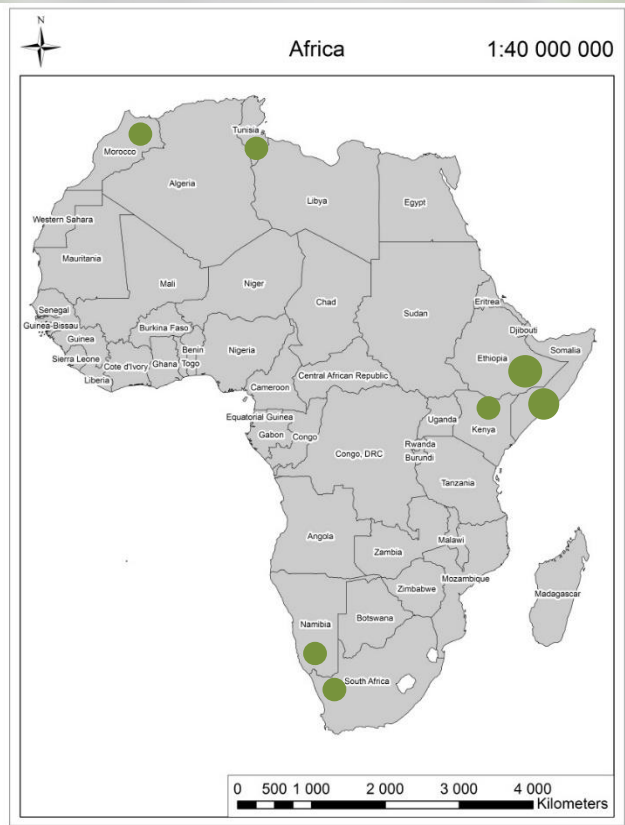


Some core findings:

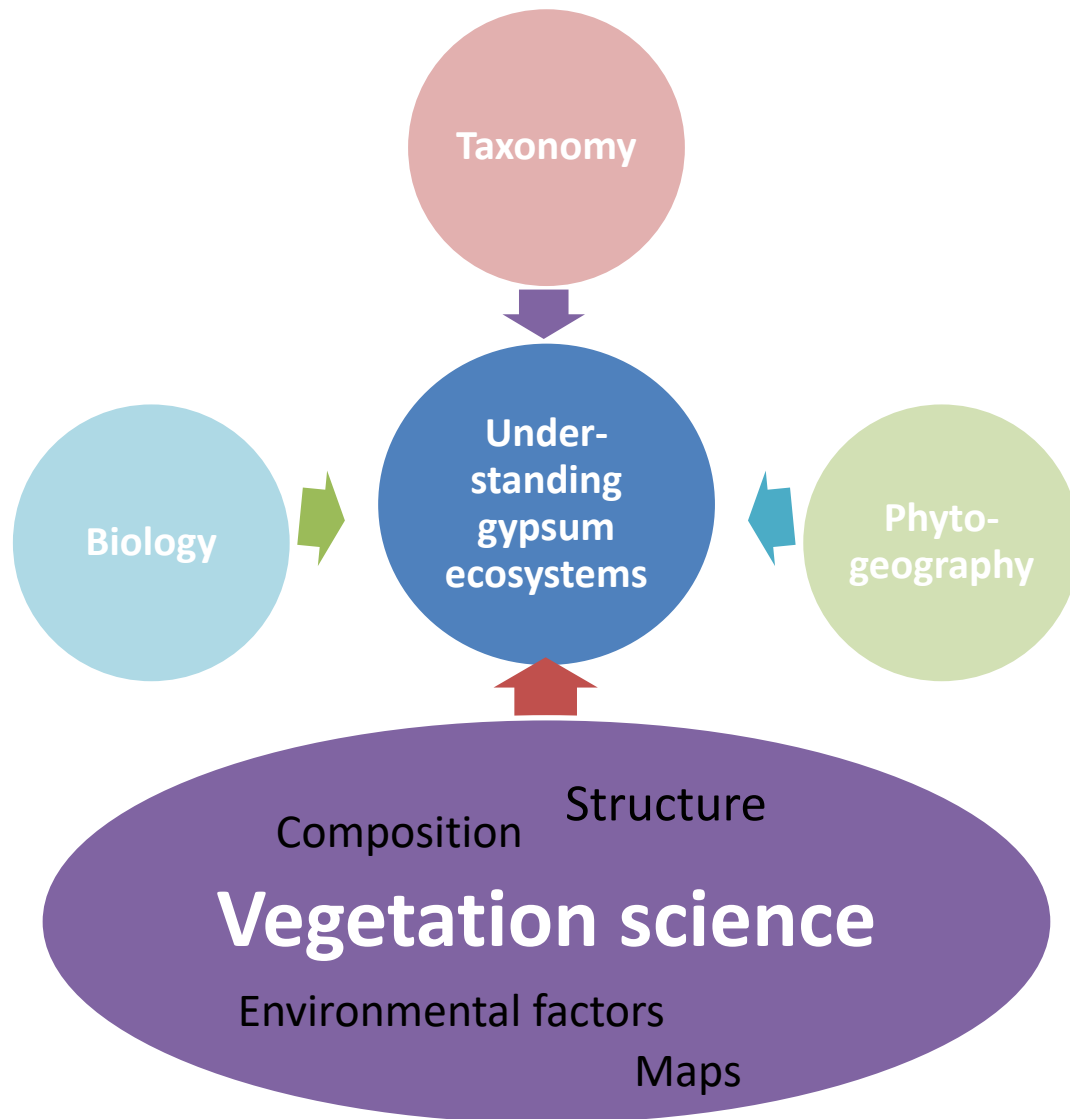


Phytogeography

- North African species mostly linked with Mediterranean (Gallego *et al.* 2002; Pocs *et al.* 2004).
- Shared species and endemism in the Horn of Africa and links with southwestern Africa (Friis *et al.* 1987; Lovett & Friis 1996).
- Restricted range distributions have implications for conservation (Friis 1987; Jurgens & Niebel 1991).
- The endemism of gypsophytes in southwestern Africa has largely been ignored (Compton 1931).

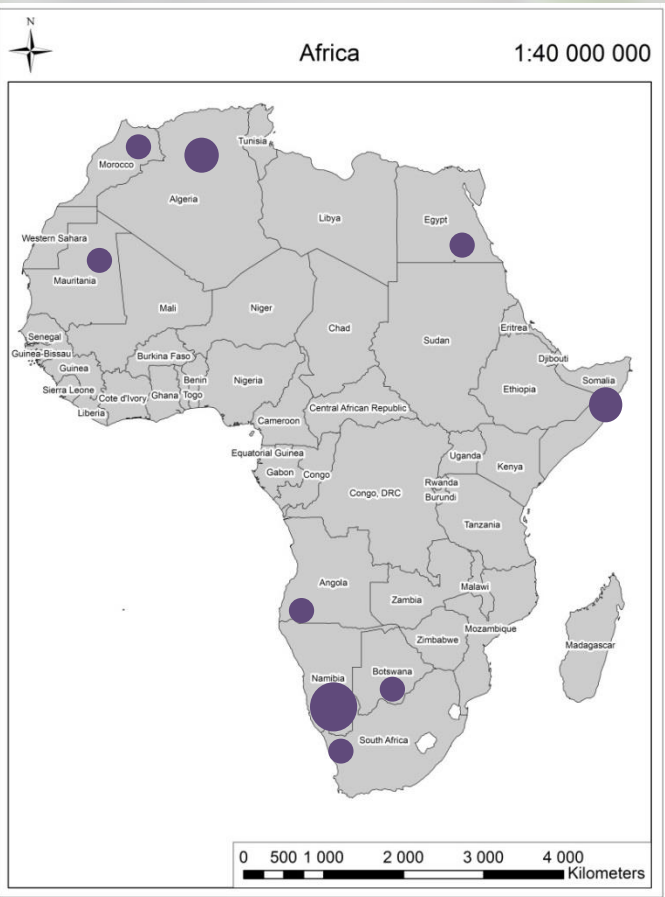


Some core findings:



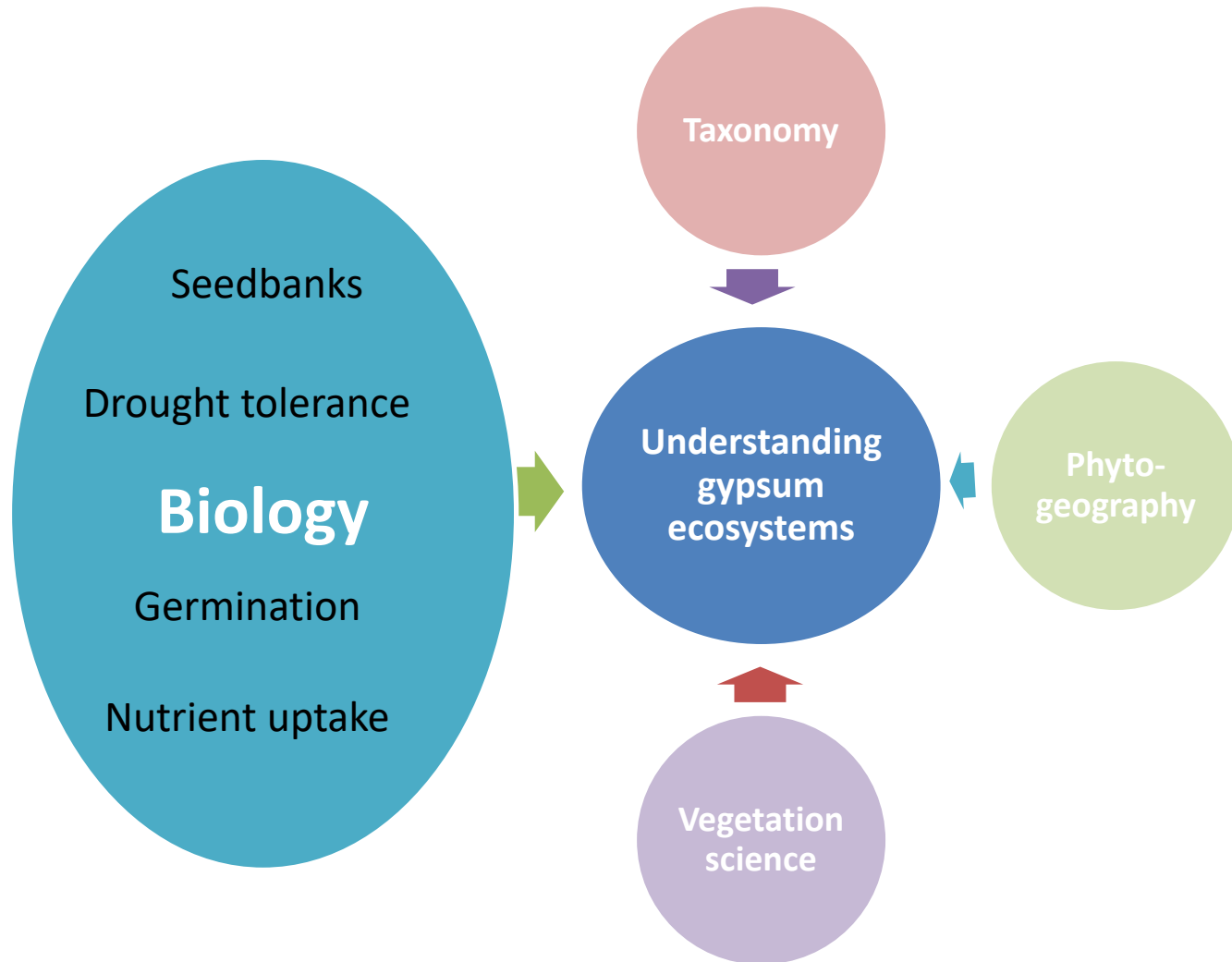
Vegetation Science

- Plant/lichen communities of gypsum ecosystems are unique in composition (Wild 1974; Jurgens 1991; Deil 2005).



- This is often ascribed to the chemical composition of gypsum soils (White 1983; Malika *et al.* 2015).
- Soil texture, compaction and salinity can influence species composition of gypsum communities (Culmsee 2002; Benghanem 2016).
- Non-soil factors such as topography, elevation, and fog can also play a role (Jurgens 2004; Wirth & Bungartz 2009).

Some core findings:



Biology



- Gypsoclines have adaptations to survive in arid gypsum environments (Struwig *et al.* 2011).
- Soil crusts are essential for nutrient cycling and germination (Ghiloufi *et al.* 2017).
- Species of similar morphology compete for resources on gypsum (Blignaut & Milton 2005).
- Serotinous seedbanks important in areas with degraded soil crusts (Gunster 1992).



Research needs

- A list of the gypsophytes from Africa (gypsophiles, gypsoclines and gypsovags) (Parsons 1976).
- Facilitation effects of species-specific, site-specific and size-specific differences (Blignaut & Milton 2005).
- Understanding biocrusts and their role in the ecosystem (Ghiloufi *et al.* 2017).
- Adaptive traits

Research needs

- Studies concerned with seed dispersal and germination requirements of gypsophytes (Gunster 1992).
- Comparative investigations between lichen fields are necessary to understand specific distribution patterns and habitat conditions (Schieferstein & Loris 1992).
- Shortage of phylogenetic studies to understand the evolutionary biology of gypsophytes (Thulin & Lavin 2001).
- Biochemical cycling

Challenges

- No funding mechanisms to mobilize African researchers to collaborate and actively pursue gypsum ecosystem research.
- No taxonomic expertise in Africa to identify lichens!! – dependent on international experts.
- No clear maps and descriptions of where all the gypsum deposits are.
- No clear understanding by botanical fraternity of what gypsum is – often regarded as calcrete or limestone

Conclusions

- Evident (although vaguely expressed at times) that unique gypsum ecosystems are present in Africa.
- There has been major focus on the description of species and communities.
- We don't understand the species specific survival traits or evolution of gypsophytes.
- More gypsum ecosystem studies needed in arid and semi-arid regions of Africa.



Thank you.



Definitions

- *Biology* involves the study of living organisms, including their physical structure, chemical composition, function, development and evolution
- *Taxonomy* involves the description and classification of organisms
- *Phytogeography* is concerned with the geographic distribution of plant species
- *Vegetation science* is the study of plant communities, their floristic composition and distribution