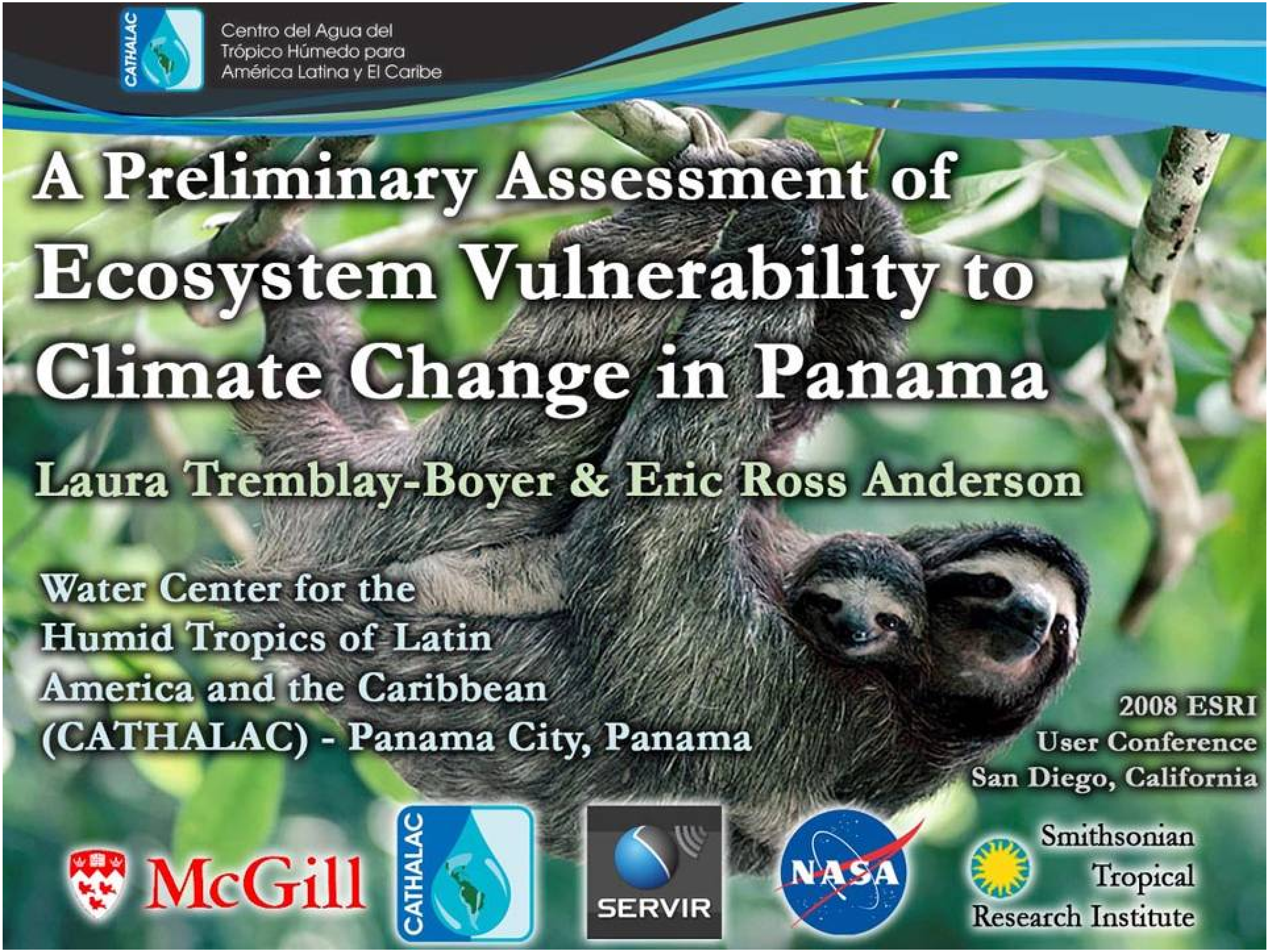

Centro del Agua del
Trópico Húmedo para
América Latina y El Caribe
CATHALAC
A Preliminary Assessment of
Ecosystem Vulnerability to
Climate Change in Panama
Laura Tremblay-Boyer & Eric Ross Anderson
Water Center for the
Humid Tropics of Latin
America and the Caribbean
(CATHALAC) - Panama City, Panama
2008 ESRI
User Conference
San Diego, California
McGill
CATHALAC
SERVIR
NASA
Smithsonian
Tropical
Research Institute

EVCC

- An index of **<u>e</u>**cosystem **<u>v</u>**ulnerability to **<u>c</u>**limate **<u>c</u>**hange
  I. Sea level rise
  II. Ecosystem geometry
  III. Climatic space
  IV. Species sensitivity
- The main tool for this project was ArcGIS

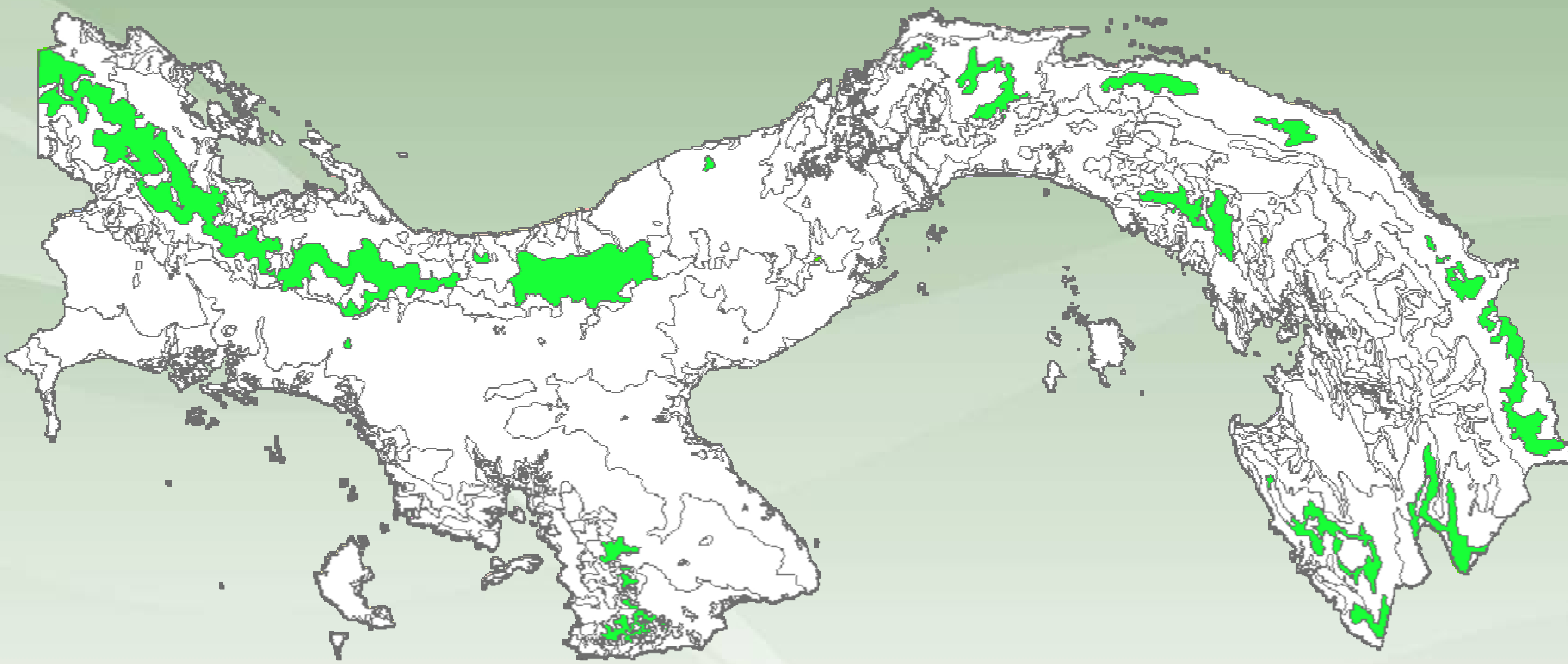
Methods

- We calculate an index of vulnerability, in four parts, for each *ecosystem patch* of Panama, according to its *ecosystem type*

- What's the difference between an ecosystem "patch" and "type"?

Ecosystems: types and patches

- 37 ecosystem types and 1303 patches



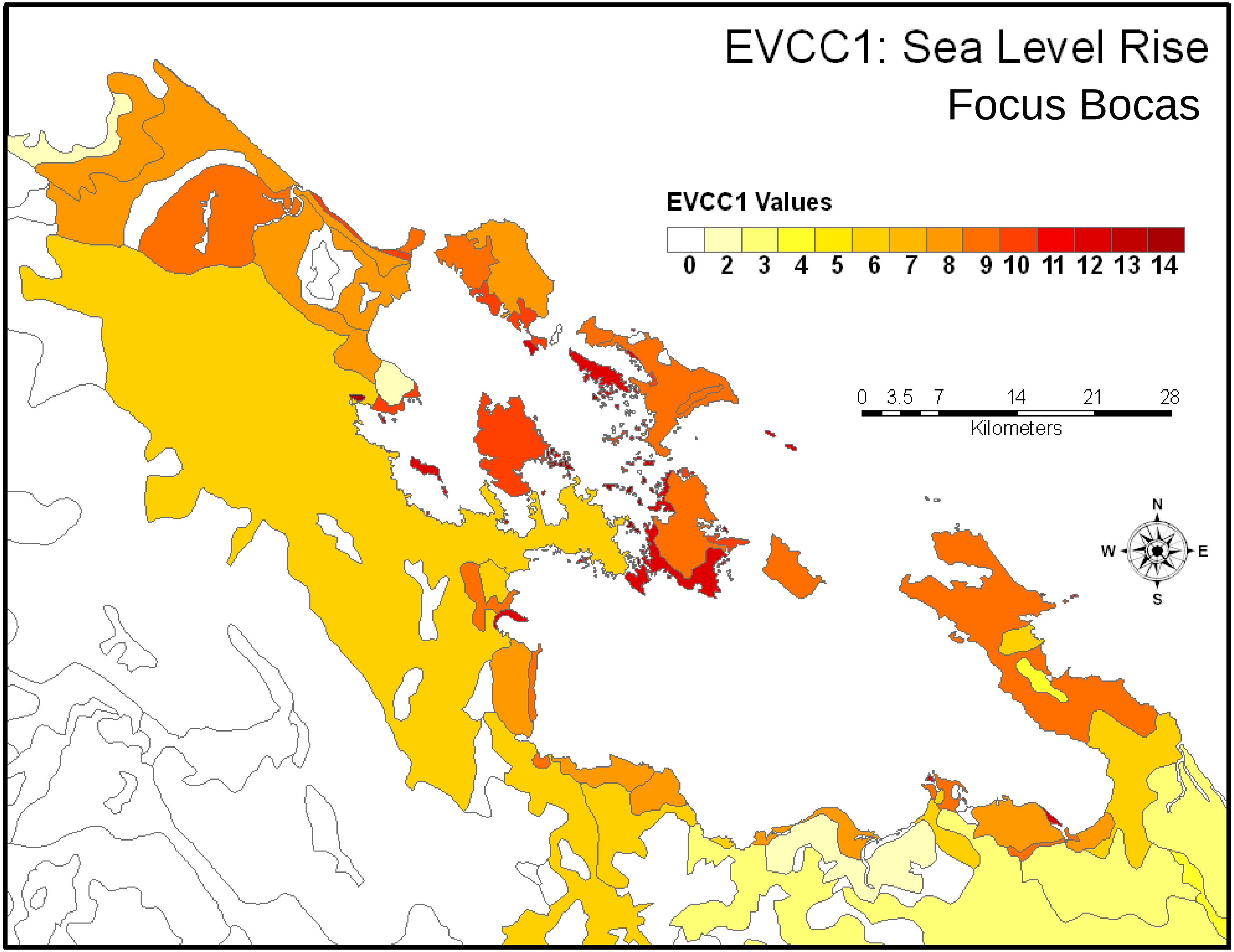
- Example: 1 ecosystem type has 27 separate and individual patches

  Tropical broadleaf evergreen submontane rainforest (500-1000m Caribbean, 700-1200m Pacific) – no human intervention

Data source: World Bank & CCAD. 2001.
http://www.worldbank.org/ca-env

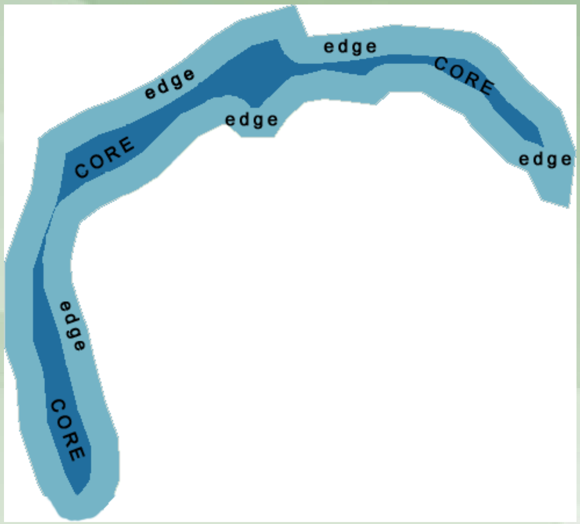
$EVCC_1$ - Sea level rise

- Select land in coastal zones with an elevation of zero to one meter
- Calculate the density of this land within each ecosystem patch
- Obtain a vulnerability value based on this density

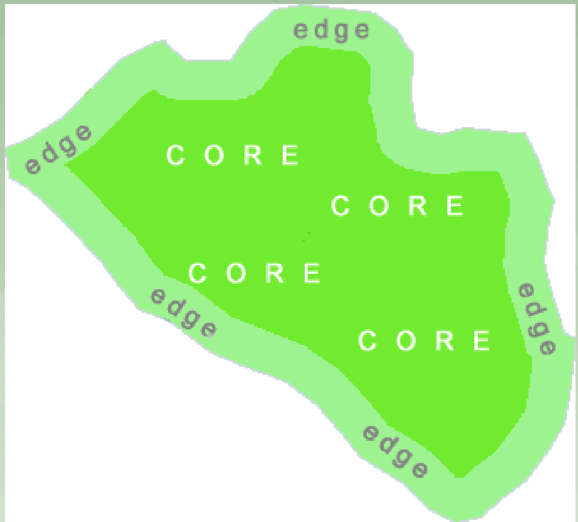

EVCC1: Sea Level Rise
Focus Bocas
EVCC1 Values
0 2 3 4 5 6 7 8 9 10 11 12 13 14
0 3.5 7 14 21 28
Kilometers
N
W
E
S

EVCC$_2$ - Ecosystem geometry

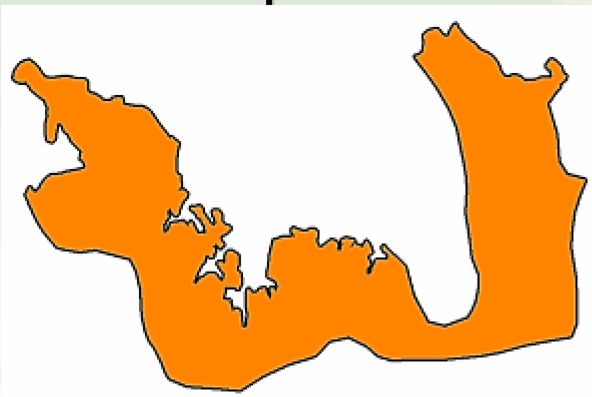
1. Ratio: edge vs. core



is more vulnerable than

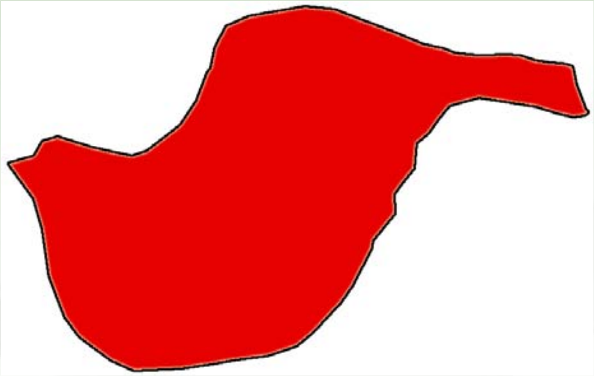


2. Relative perimeter

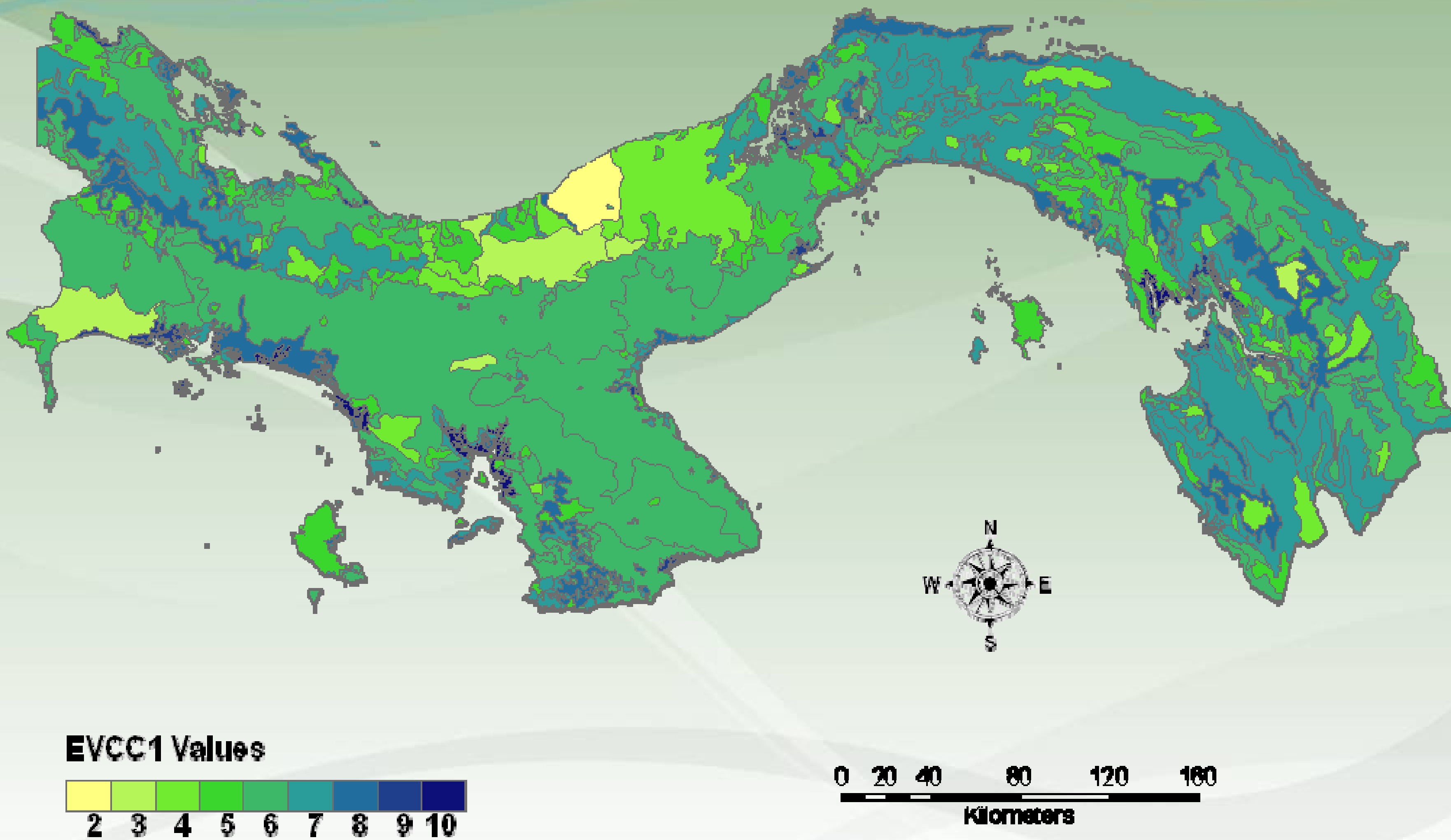


C

is more vulnerable than



EVCC$_2$ - Ecosystem geometry



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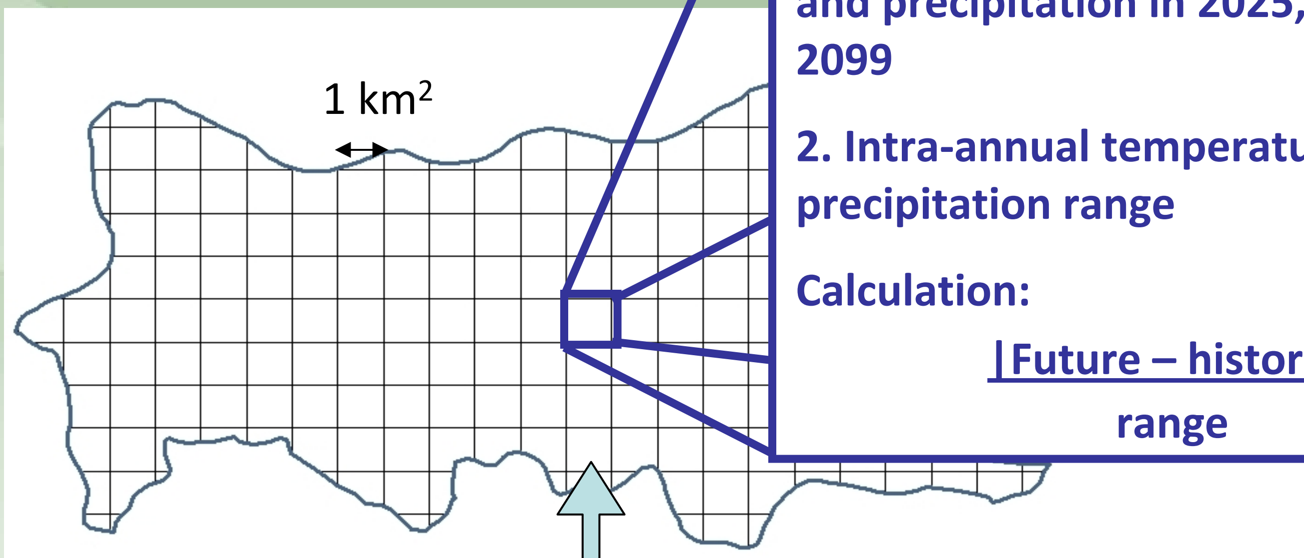
América Latina y El Caribe

EVCC$_3$ - Climatic space



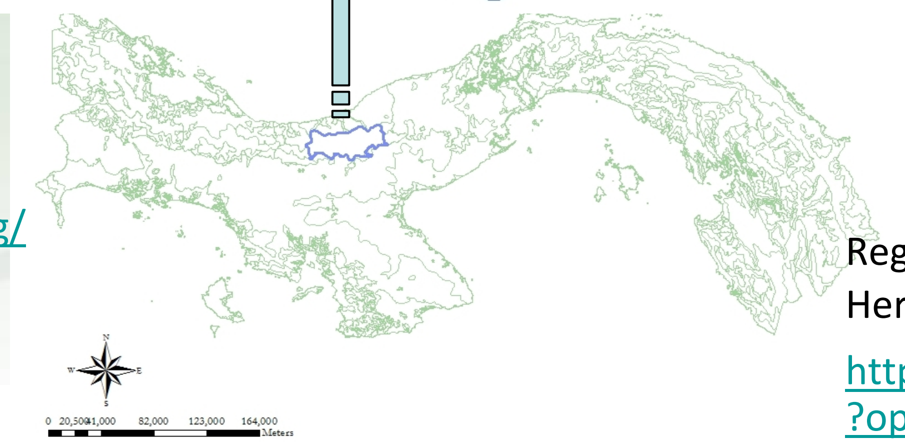
<u>Gower Metric for each 1 km^2 cell:</u>

1. Predicted change in temperature and precipitation in 2025, 2050, and 2099

2. Intra-annual temperature and precipitation range

Calculation:

$$\frac{|\text{Future} - \text{historic}|}{\text{range}}$$



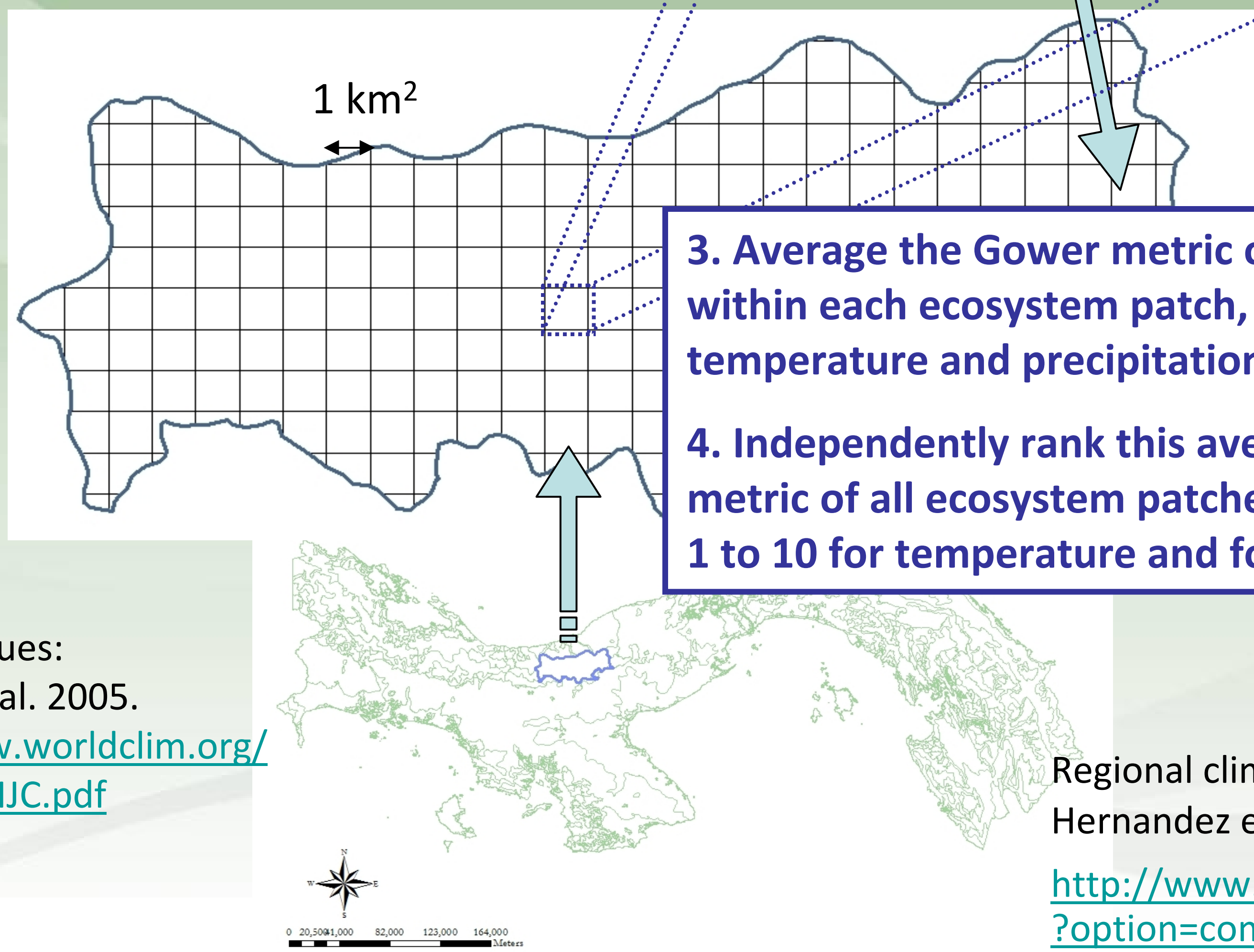
Historic values:
Hijmans et al. 2005.
http://www.worldclim.org/worldclim_IJC.pdf

Regional climate change model:
Hernandez et al. 2006.

http://www.servir.net/index.php?option=com_content&task=view&id=31&Itemid=68

EVCC$_3$ - Climatic space

Gower Metric for each 1 km^2 cell



3. Average the Gower metric of all cells within each ecosystem patch, for temperature and precipitation

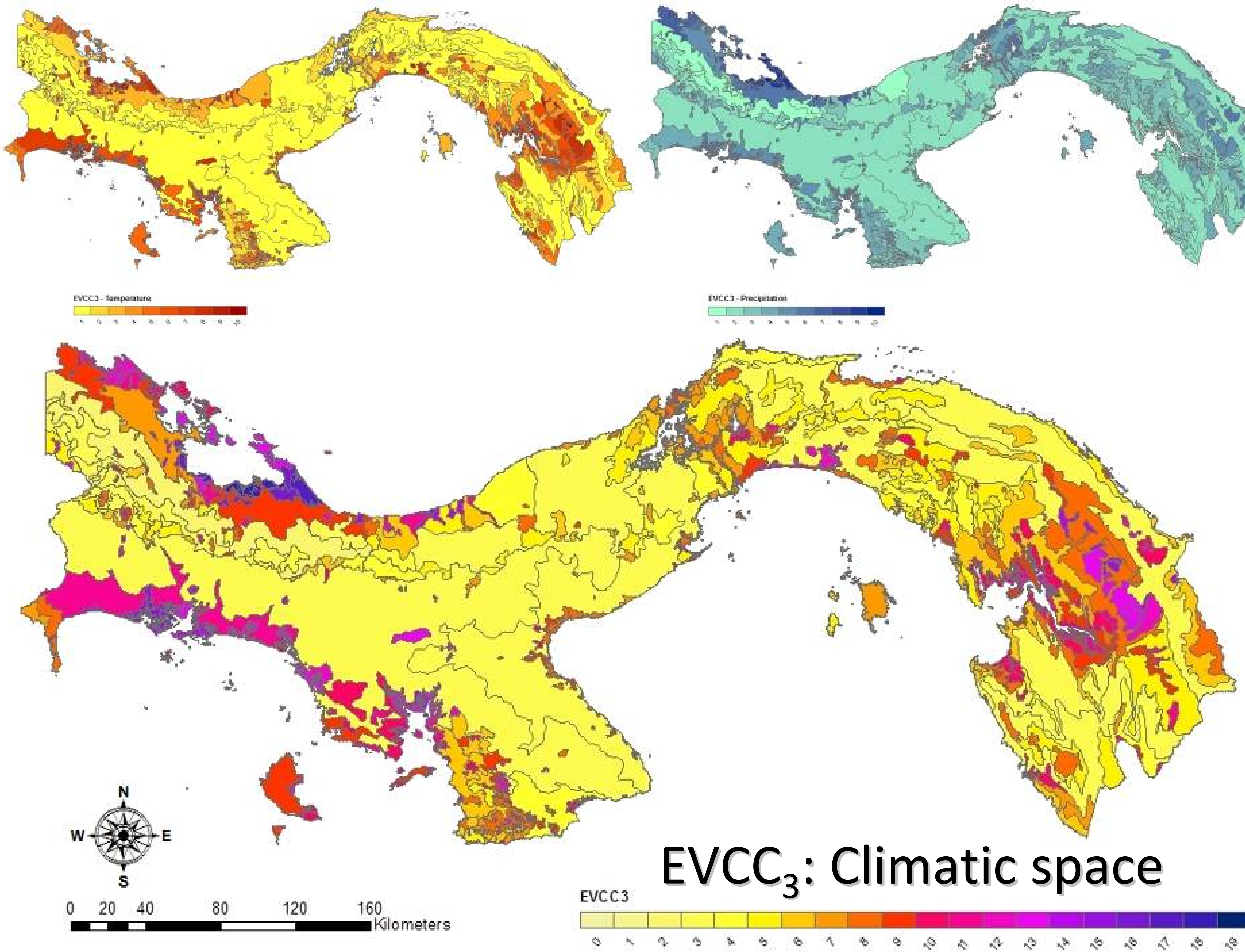
4. Independently rank this averaged Gower metric of all ecosystem patches on a scale of 1 to 10 for temperature and for precipitation

Historic values:
Hijmans et al. 2005.
http://www.worldclim.org/worldclim_IJC.pdf

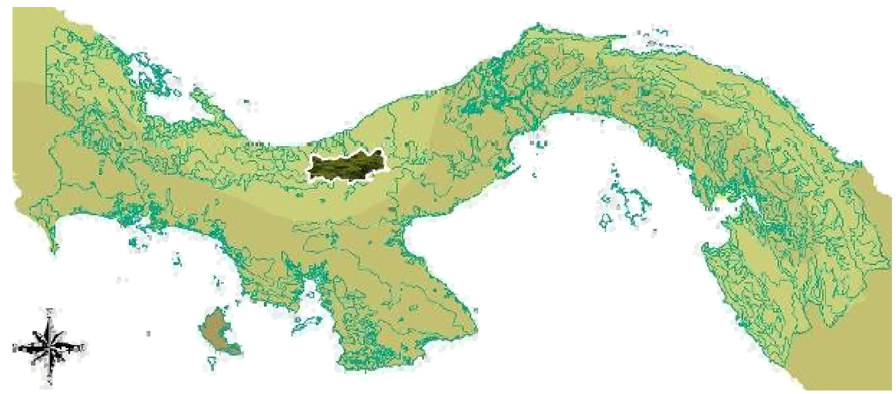
Regional climate change model:
Hernandez et al. 2006.

http://www.servir.net/index.php?option=com_content&task=view&id=31&Itemid=68

EVCC$_3$: Climatic space



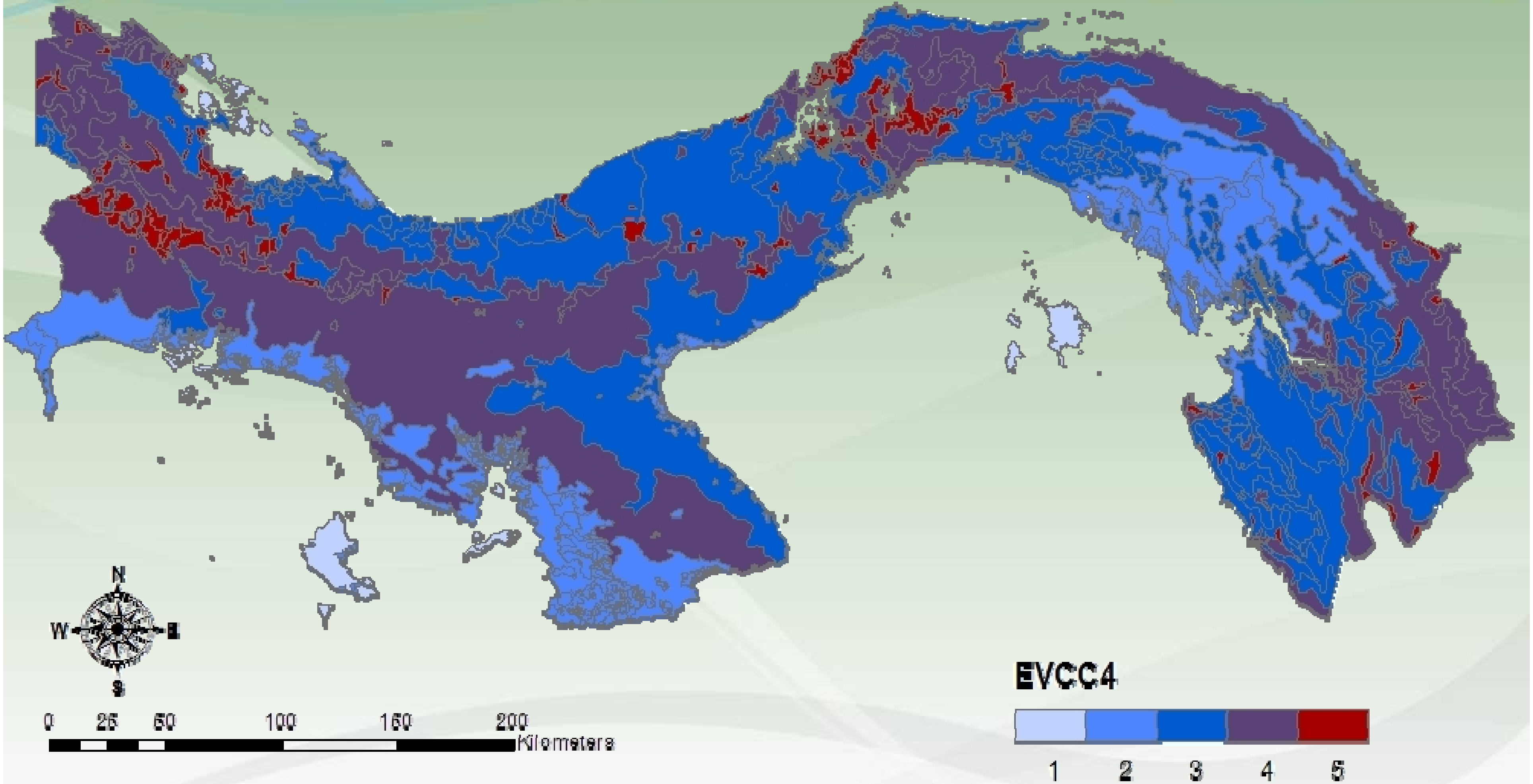
EVCC$_4$ – Species sensitivity



InfoNatura: Animals and Ecosystems of Latin America

http://www.natureserve.org/infonatura

EVCC$_4$ – Species sensitivity



Overall vulnerability

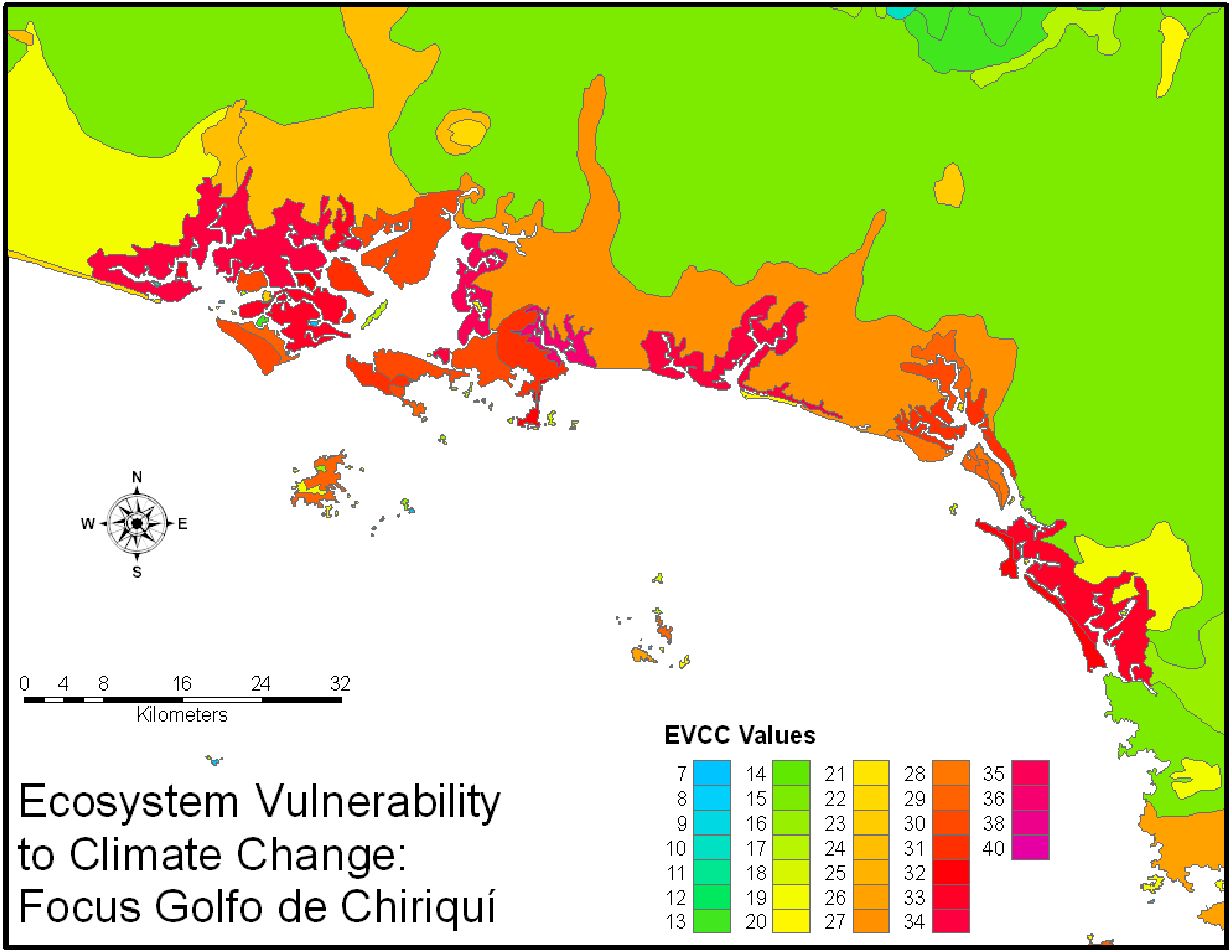
According to the quality and pertinence of the data, the following is the rank of importance for each domain:

Climatic space

Sea level rise

Ecosystem geometry

Species sensitivity


N
W
E
S
0
4
8
16
24
32
Kilometers
EVCC Values
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
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31
32
33
34
35
36
38
40
Ecosystem Vulnerability
to Climate Change:
Focus Golfo de Chiriquí

Additional Applications

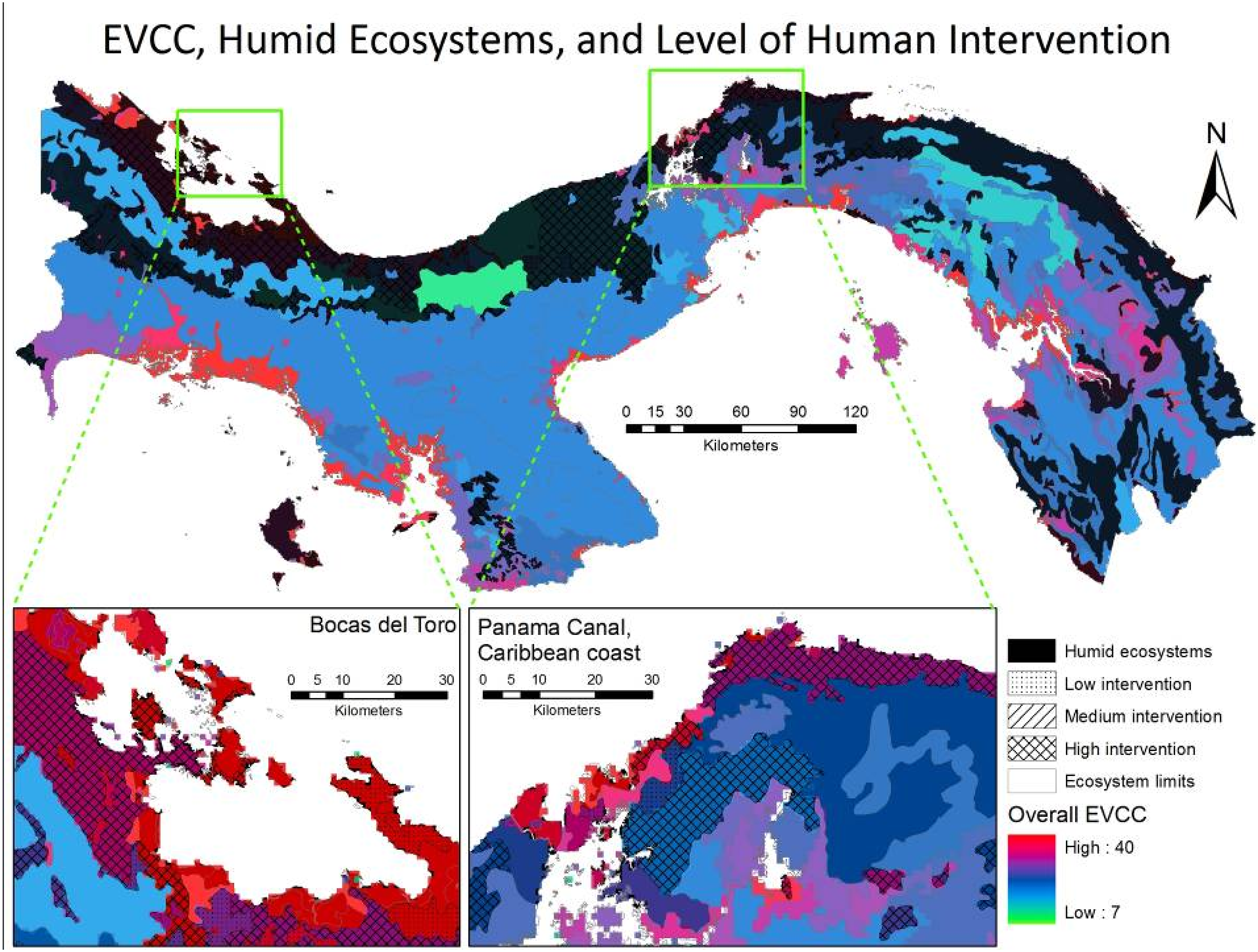
- Human intervention
- Humid ecosystems
- Protected areas
- Species richness

EVCC & level of human intervention

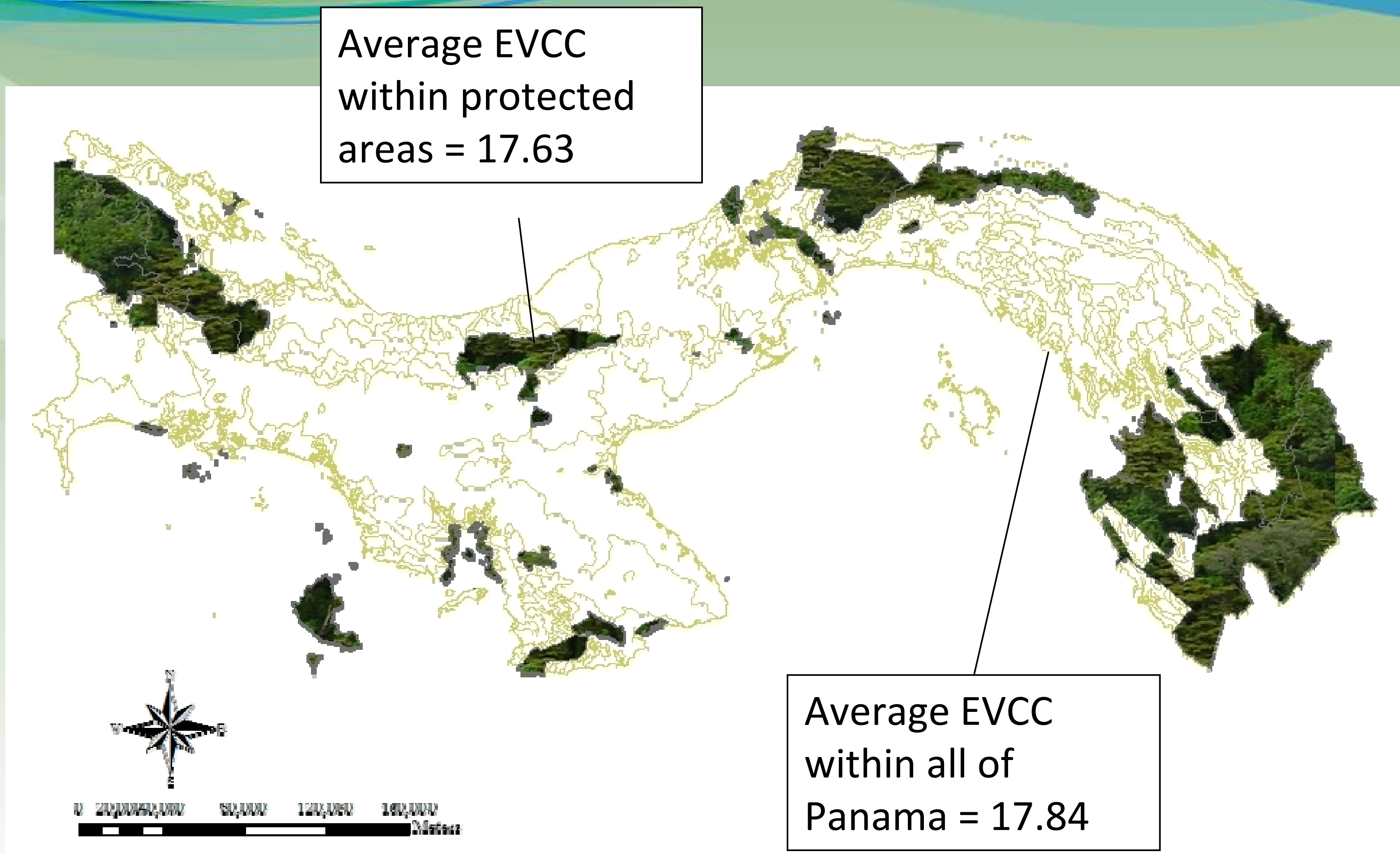
		Level of intervention	Ave_EVCC_1	Ave_EVCC_2	Ave_EVCC_3	Ave_EVCC_4	Ave_EVCC
	0	**None**	**5.10**	**6.41**	4.68	2.27	18.45
Natural	1	**Low**	2.16	6.27	8.25	**3.47**	20.16
Natural	2	**Medium**	0.00	5.00	7.00	**3.50**	15.50
Natural	3	**High, in mountains**	0.00	5.77	7.43	**4.09**	17.29
Natural	4	**High, in lowlands**	2.70	6.32	8.52	2.87	20.41
Productive	5	**10-50% natural vegetation remains**	3.23	6.32	8.13	3.23	20.92
Productive	6	**<10% natural vegetation remains**	**4.57**	6.37	**9.15**	2.74	**22.83**
Productive	7	**Agroforestry**	0.00	6.33	**10.83**	3.17	20.33
Productive	8	**Shrimp / Salt**	**4.67**	**6.83**	7.33	2.00	**20.83**
	9	**Populated place**	3.90	**6.76**	**8.57**	3.14	**22.38**

Red = highest average; orange = second highest; yellow = third highest

Blue = most commonly ranked with high vulnerability

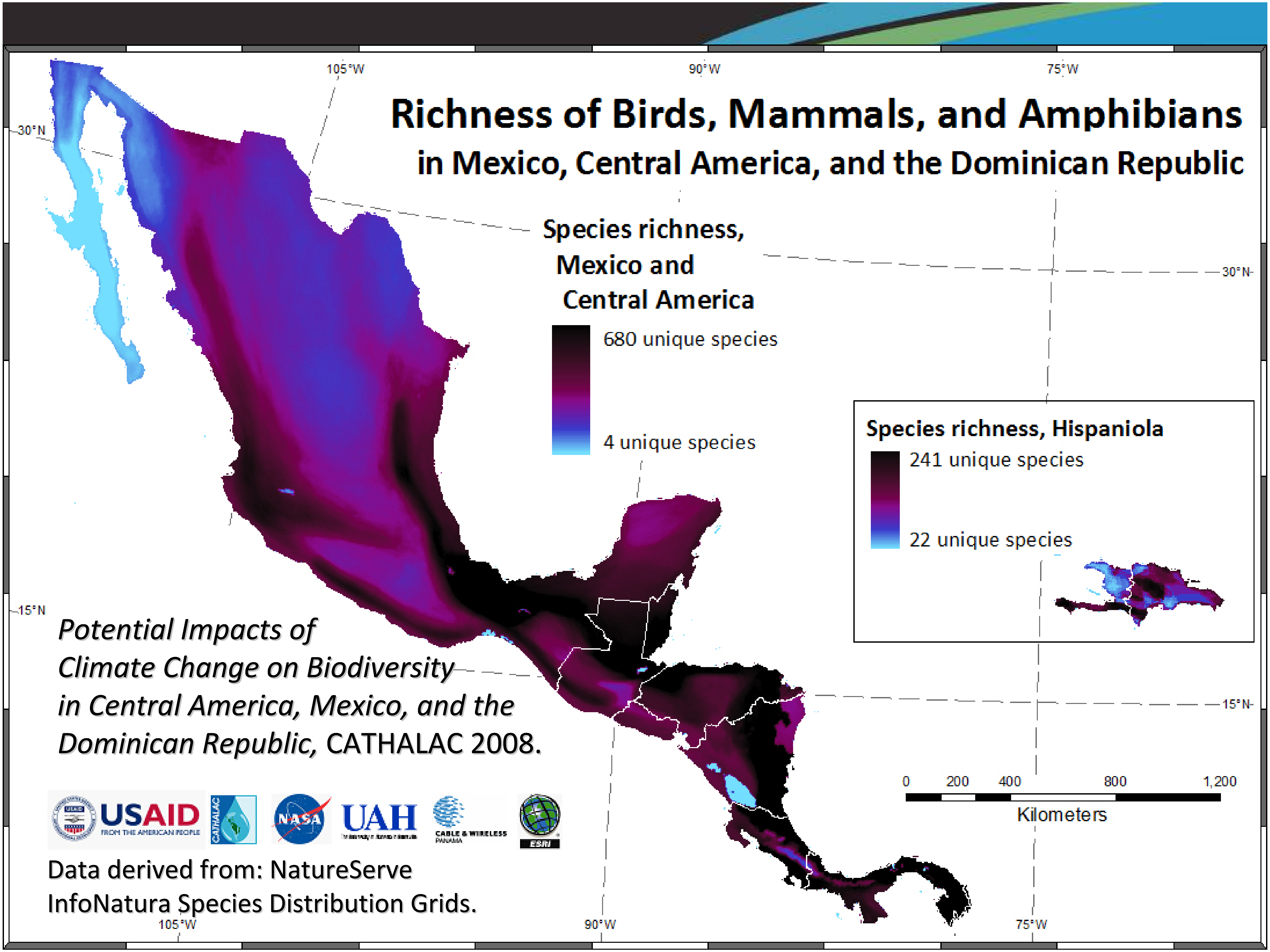

EVCC, Humid Ecosystems, and Level of Human Intervention
N
0 15 30 60 90 120
Kilometers
Bocas del Toro
0 5 10 20 30
Kilometers
Panama Canal,
Caribbean coast
0 5 10 20 30
Kilometers
Humid ecosystems
Low intervention
Medium intervention
High intervention
Ecosystem limits
Overall EVCC
High : 40
Low : 7

EVCC & Protected Areas

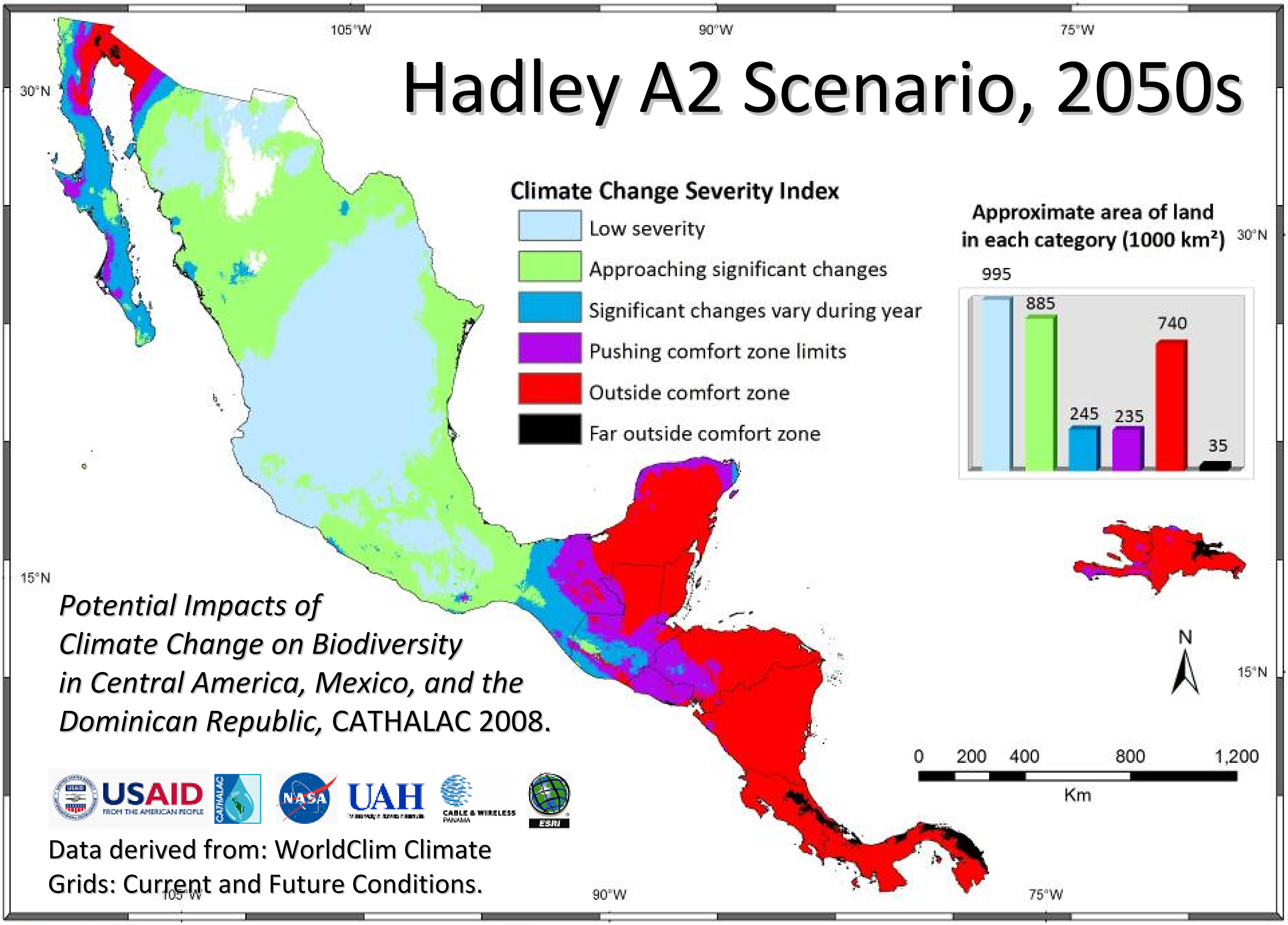


Expanding the study

- ***Regional*** biodiversity
- ***Regional*** climate change severity index (similar to $EVCC_3$)
- Integration of both to identify **critical habitats**

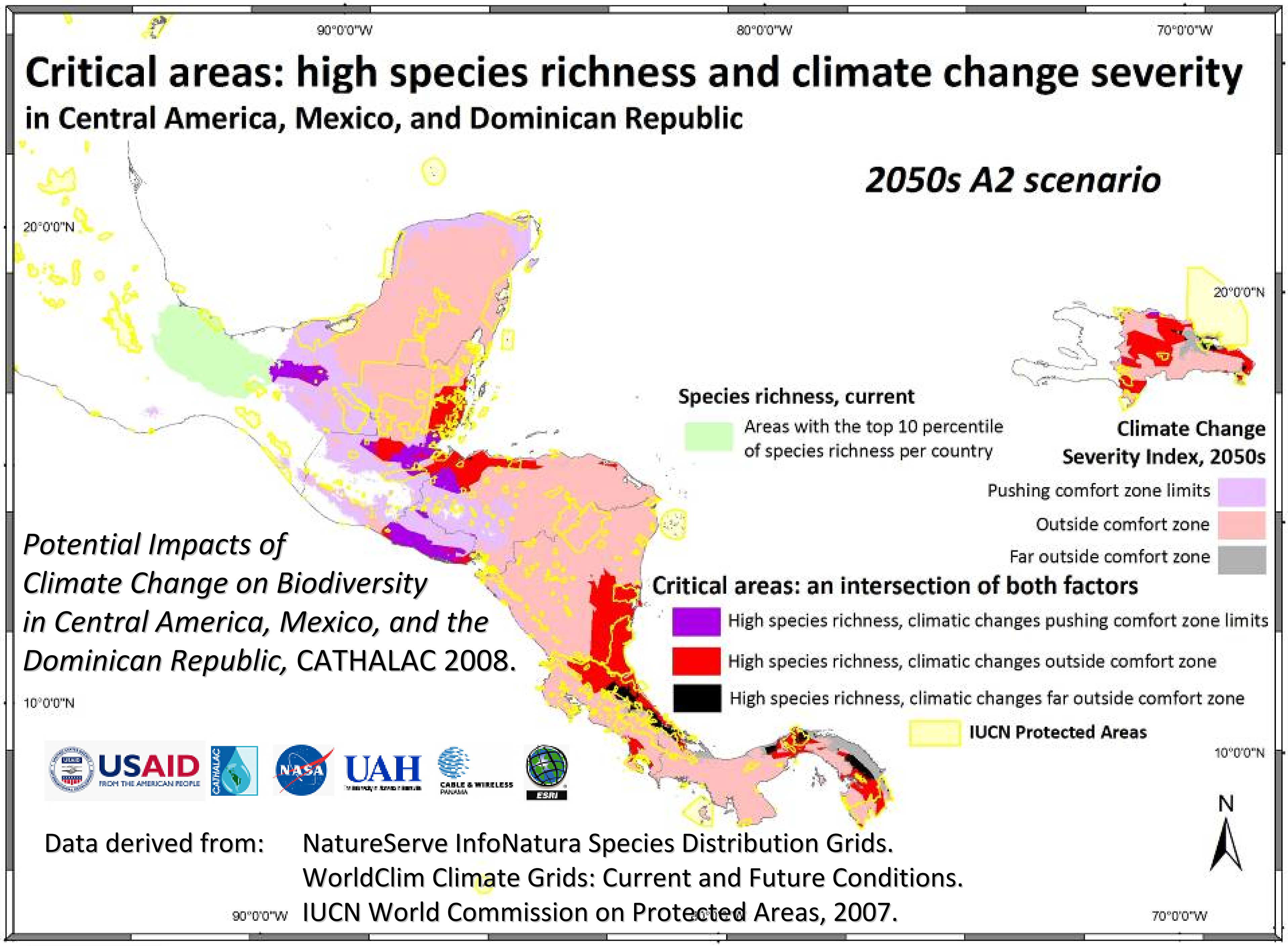

Richness of Birds, Mammals, and Amphibians
in Mexico, Central America, and the Dominican Republic
Species richness,
Mexico and
Central America
680 unique species
4 unique species
Species richness, Hispaniola
241 unique species
22 unique species
105°W
90°W
75°W
30°N
15°N
0
200
400
800
1,200
Kilometers
Potential Impacts of
Climate Change on Biodiversity
in Central America, Mexico, and the
Dominican Republic, CATHALAC 2008.
USAID FROM THE AMERICAN PEOPLE
CATHALAC
NASA
UAH
CABLE & WIRELESS PANAMA
ESRI
Data derived from: NatureServe
InfoNatura Species Distribution Grids.

Hadley A2 Scenario, 2050s



Potential Impacts of Climate Change on Biodiversity in Central America, Mexico, and the Dominican Republic, CATHALAC 2008.

Data derived from: WorldClim Climate Grids: Current and Future Conditions.


Critical areas: high species richness and climate change severity
in Central America, Mexico, and Dominican Republic
2050s A2 scenario
90°0'0"W
80°0'0"W
70°0'0"W
20°0'0"N
10°0'0"N
Species richness, current
Areas with the top 10 percentile of species richness per country
Climate Change Severity Index, 2050s
Pushing comfort zone limits
Outside comfort zone
Far outside comfort zone
Critical areas: an intersection of both factors
High species richness, climatic changes pushing comfort zone limits
High species richness, climatic changes outside comfort zone
High species richness, climatic changes far outside comfort zone
IUCN Protected Areas
Potential Impacts of Climate Change on Biodiversity in Central America, Mexico, and the Dominican Republic, CATHALAC 2008.
USAID FROM THE AMERICAN PEOPLE
CATHALAC
NASA
UAH
CABLE & WIRELESS PANAMA
ESRI
N
Data derived from: NatureServe InfoNatura Species Distribution Grids.
WorldClim Climate Grids: Current and Future Conditions.
IUCN World Commission on Protected Areas, 2007.

Conclusions

- The EVCC index has the potential to be a very useful tool for conservation of large-scale biodiversity (e.g., identification of critical areas)
- It is important to include the uncertainties and to be flexible in the application of this index, always including and improving it with the latest scientific knowledge (e.g., more climate change scenarios)
- Climate change should be evaluated in conjunction with other factors that threaten ecosystems (e.g., land cover change scenarios)

Acknowledgements

- Our professors and supervisors, and host institutions
  - Emil Cherrington, CATHALAC
  - Roxana Segundo, CATHALAC
  - Roberto Ibáñez, STRI
  - Catherine Potvin, McGill University

- For more information, please visit:
  - http://evcc-panama.mcgill.ca