

climate change adaptation & sustainable development

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ENVIRONMENT

UNIVERSITY OF MINNESOTA
Driven to DiscoverSM





6°C
11°F

>30 days over
95°F each
year!



change in avg T (°C)





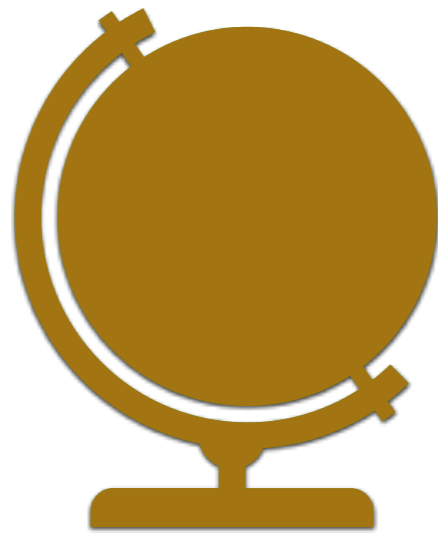
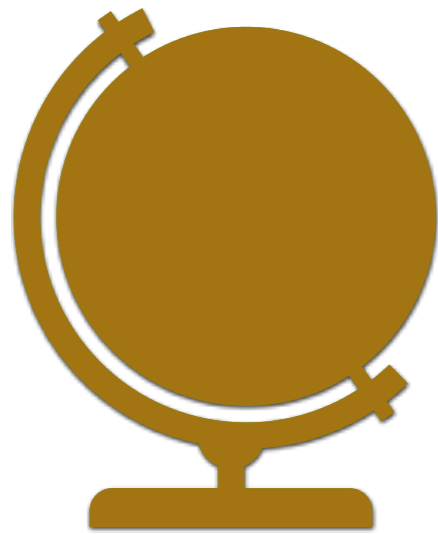
Smith et al. 2009 | Eberle et al. 2010

900,000 species



What do
we do?

STOP!



3700 Gt

economic
revolution



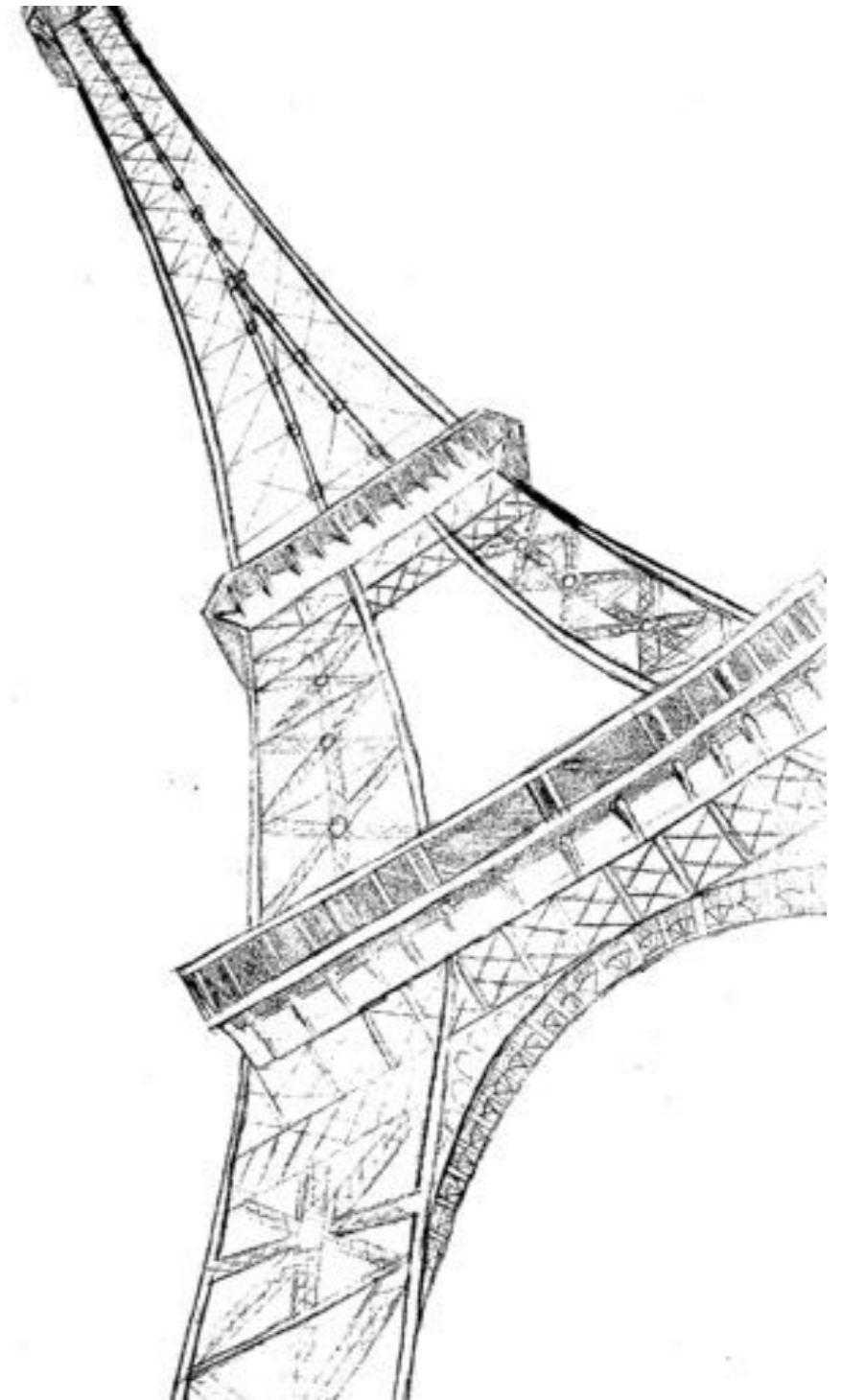


Mitigation

Adaptation



...**holding the increase in the global average temperature to well below 2 °C** above pre- industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre- industrial levels...



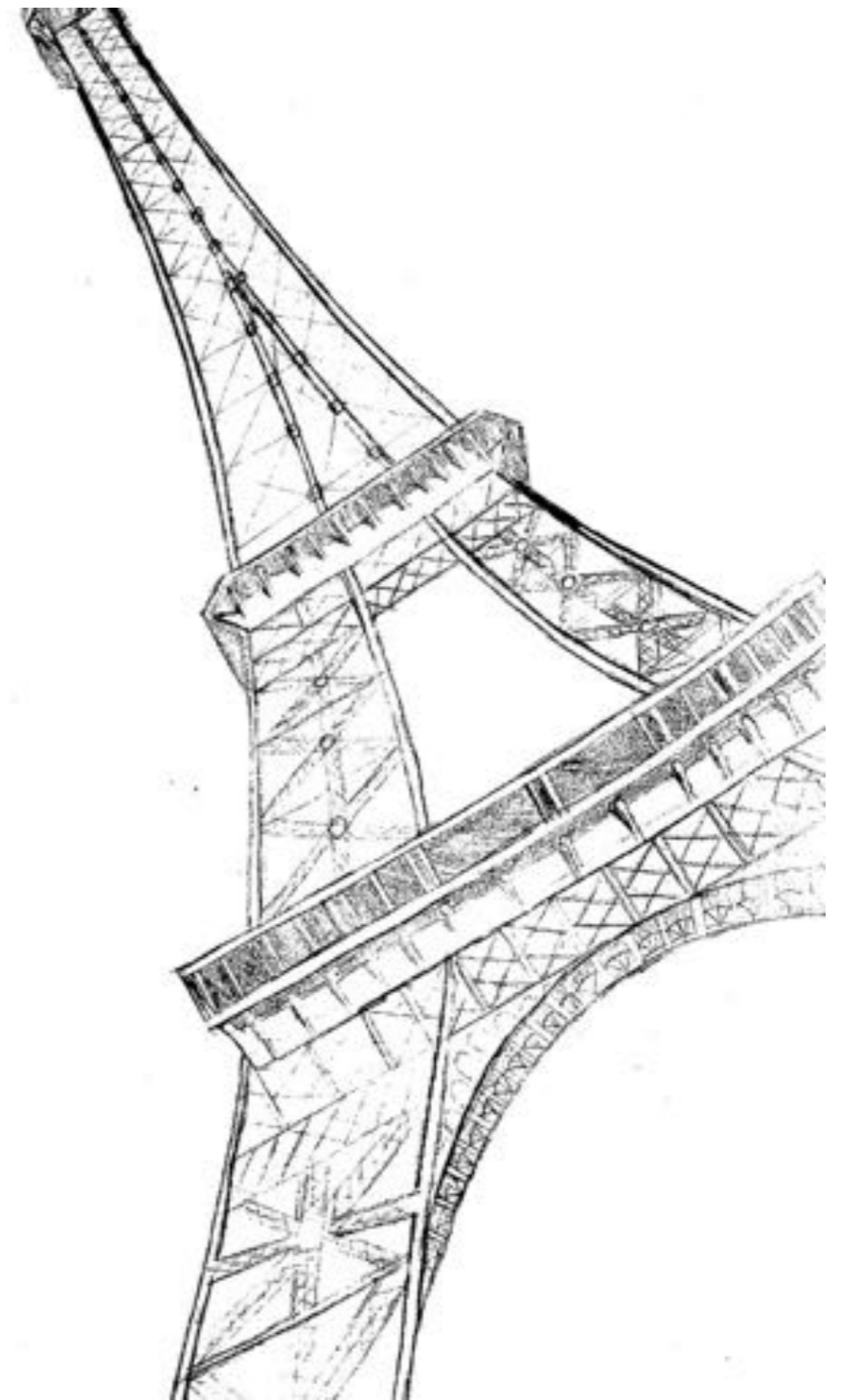
Mitigation

50

Adaptation

85

... strongly urges developed country Parties to scale up their level of financial support, with a concrete roadmap to achieve the goal of **jointly providing USD 100 billion annually by 2020** for mitigation and adaptation ...



Adaptation

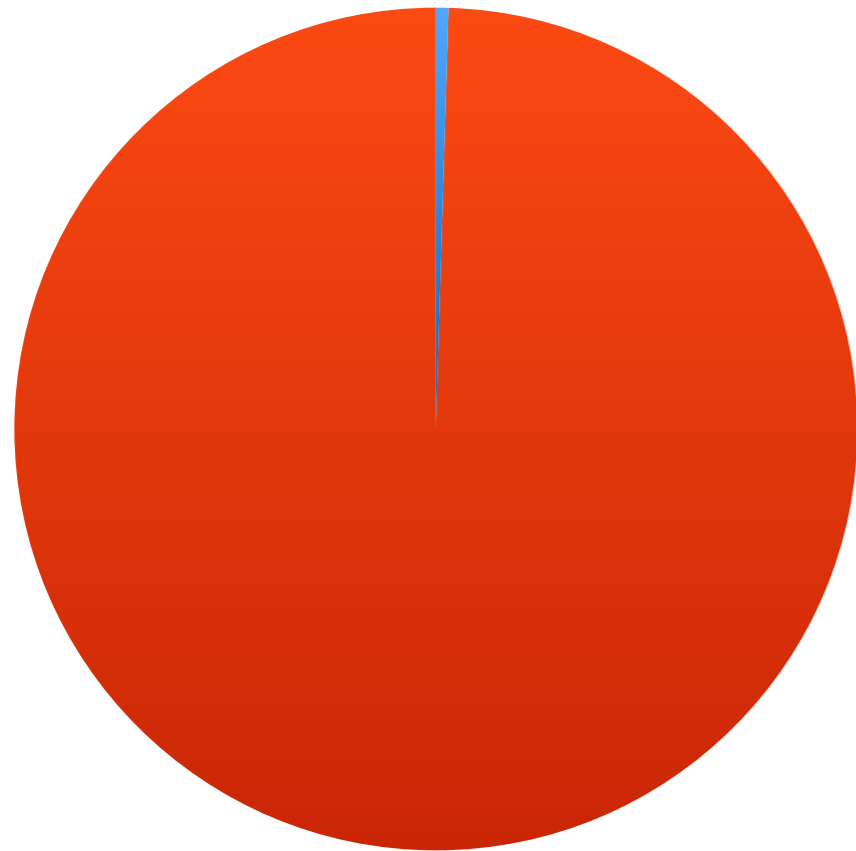


- 1 Paris set mitigation *and* adaptation goals
- 2 Adaptation needs *investment*
- 3 Need to *bend curve* in adaptation
- 4 *Migration* is an adaptation strategy
- 5 *Nature* is an adaptation strategy

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- 2 Adaptation needs *investment*

\$500B per year

Financing gap



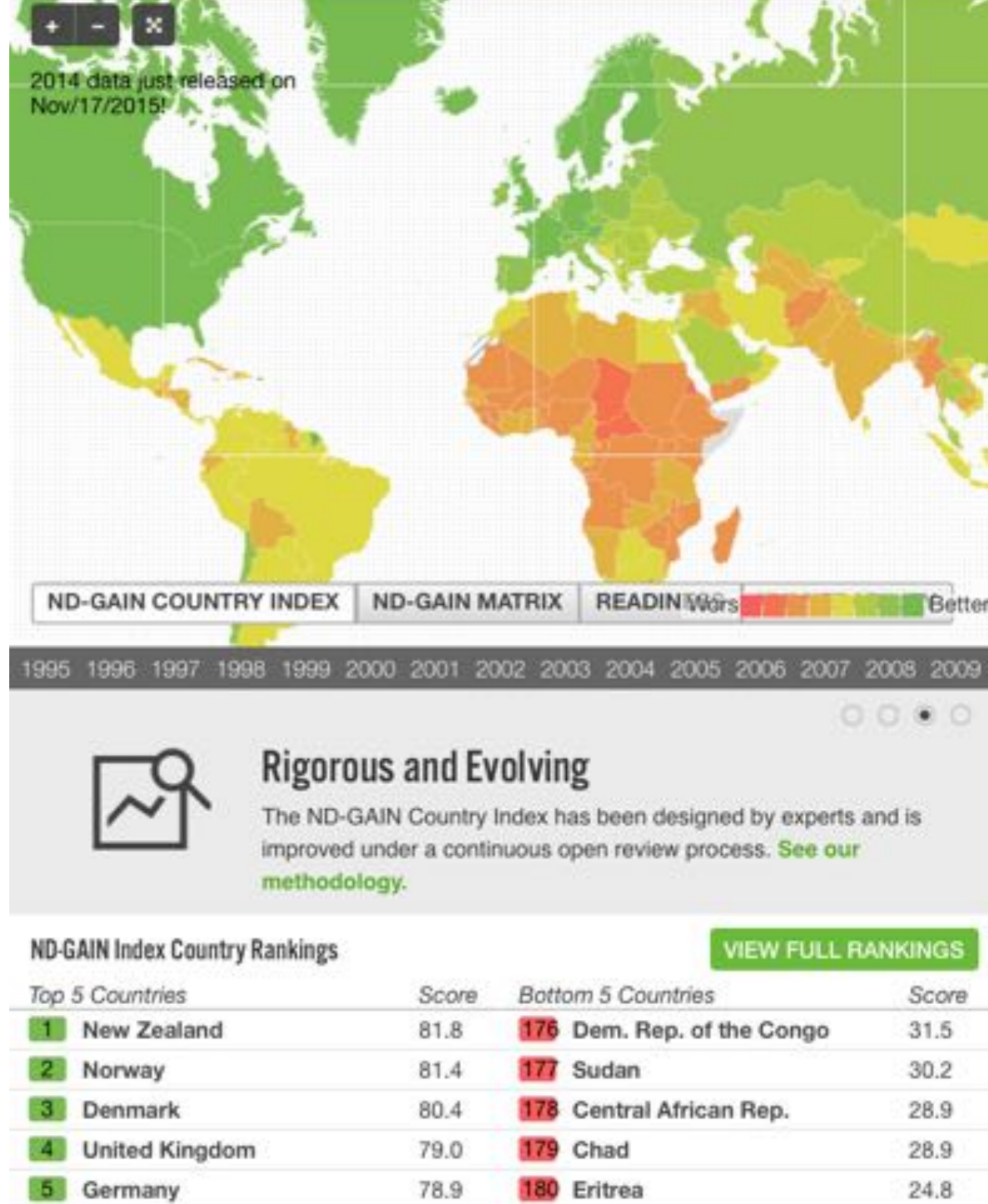
Fund: \$483 million

Goal: \$100 billion/2020

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Country index

- 45 indicators
- 180 countries
- 1995-2017
- open & authoritative data



Vulnerability



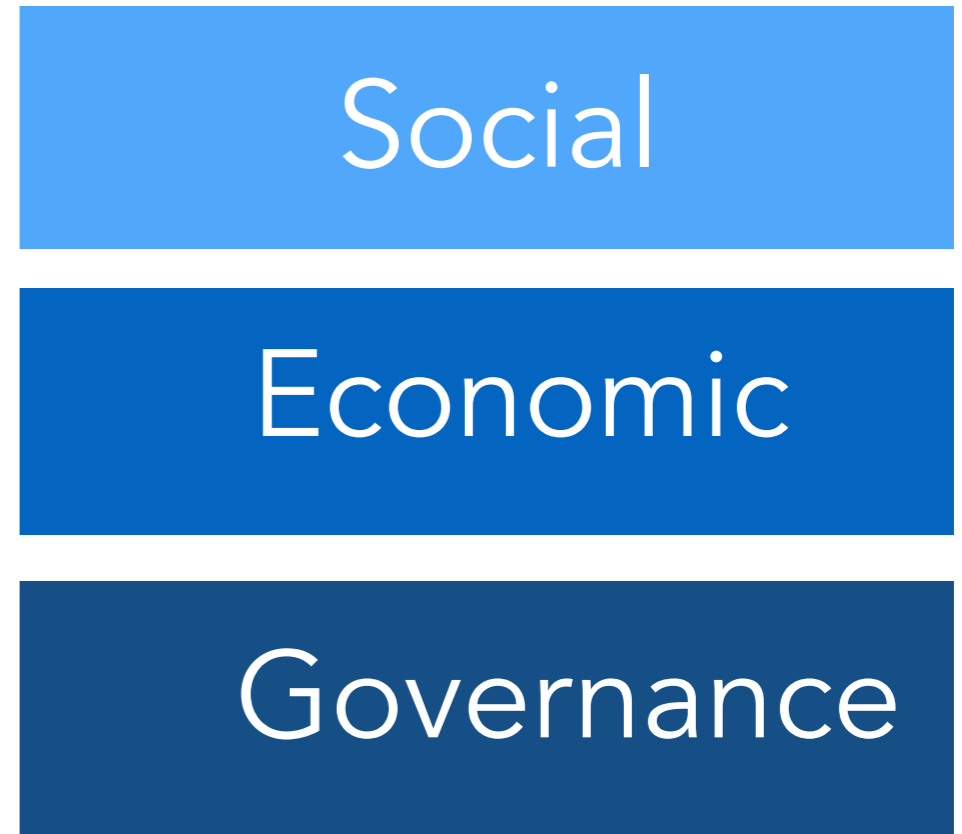
Exposure

Sensitivity

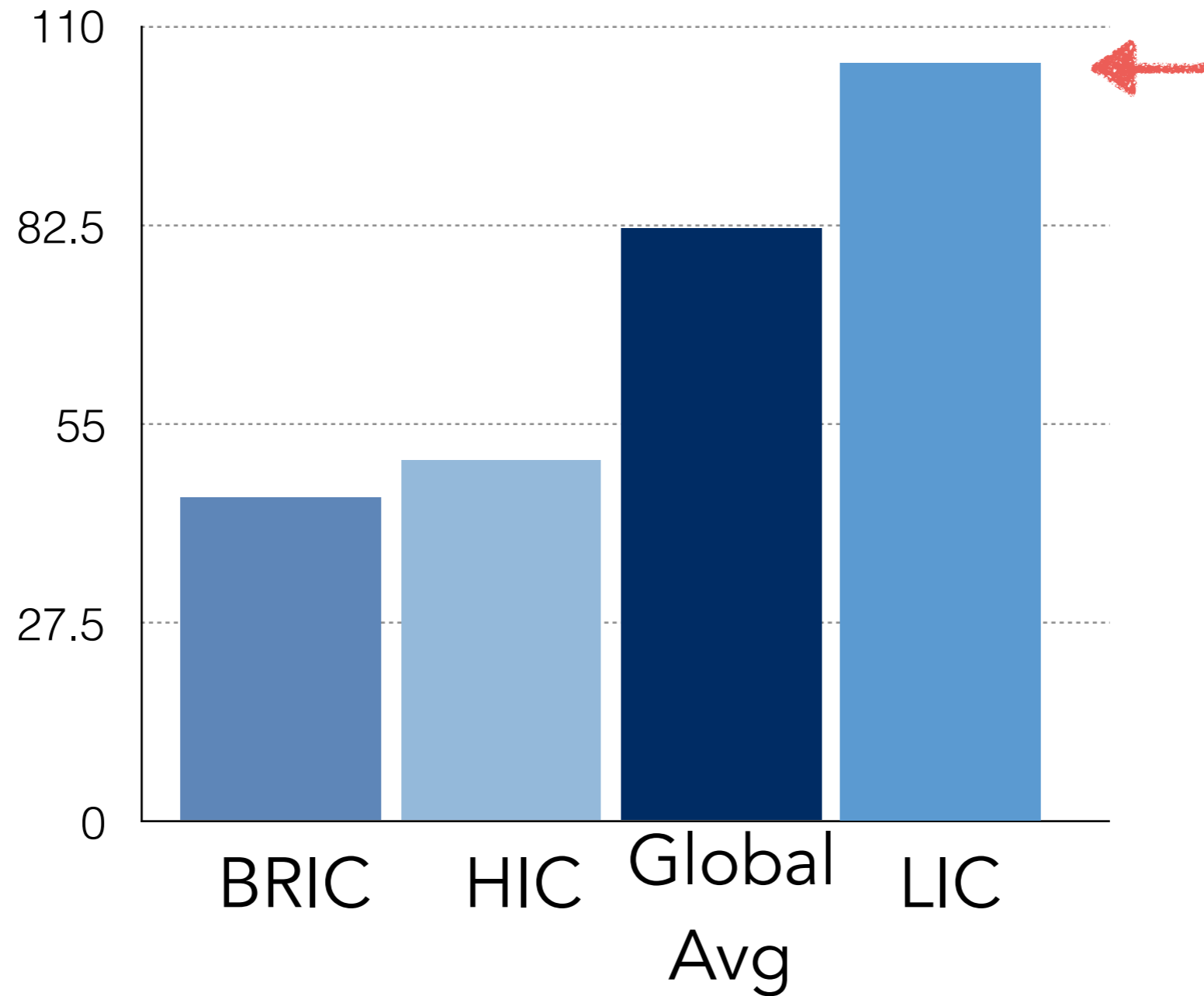
Adaptive capacity

X

Readiness



Years to reach average adaptive capacity of OECD



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2010-2015
intl migration



Vulnerability

Water

Food

Ecosystems

Health

Human Habitats

Infrastructure

Exposure

Sensitivity

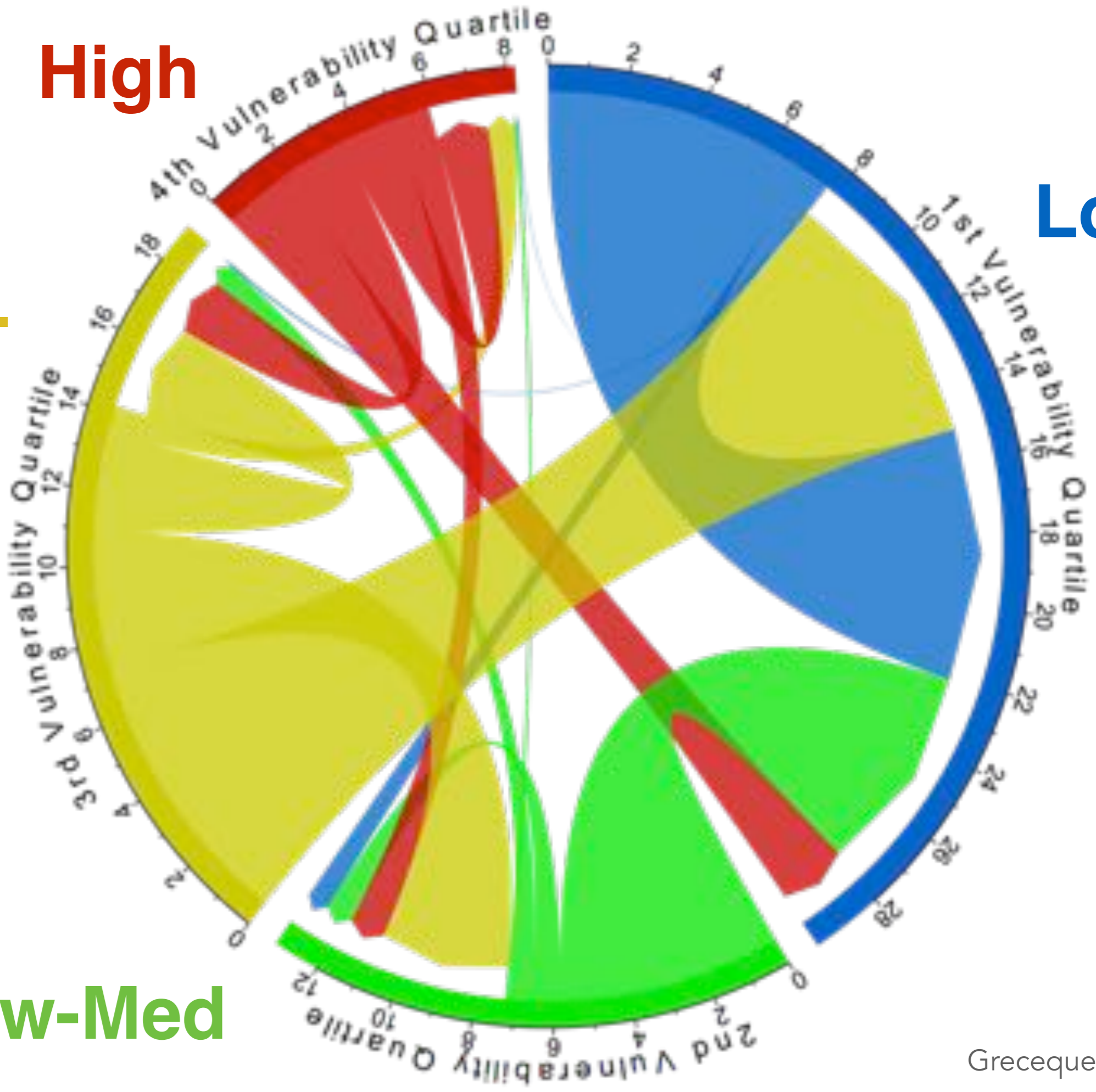
Adaptive capacity

High

Low

High-Med

Low-Med

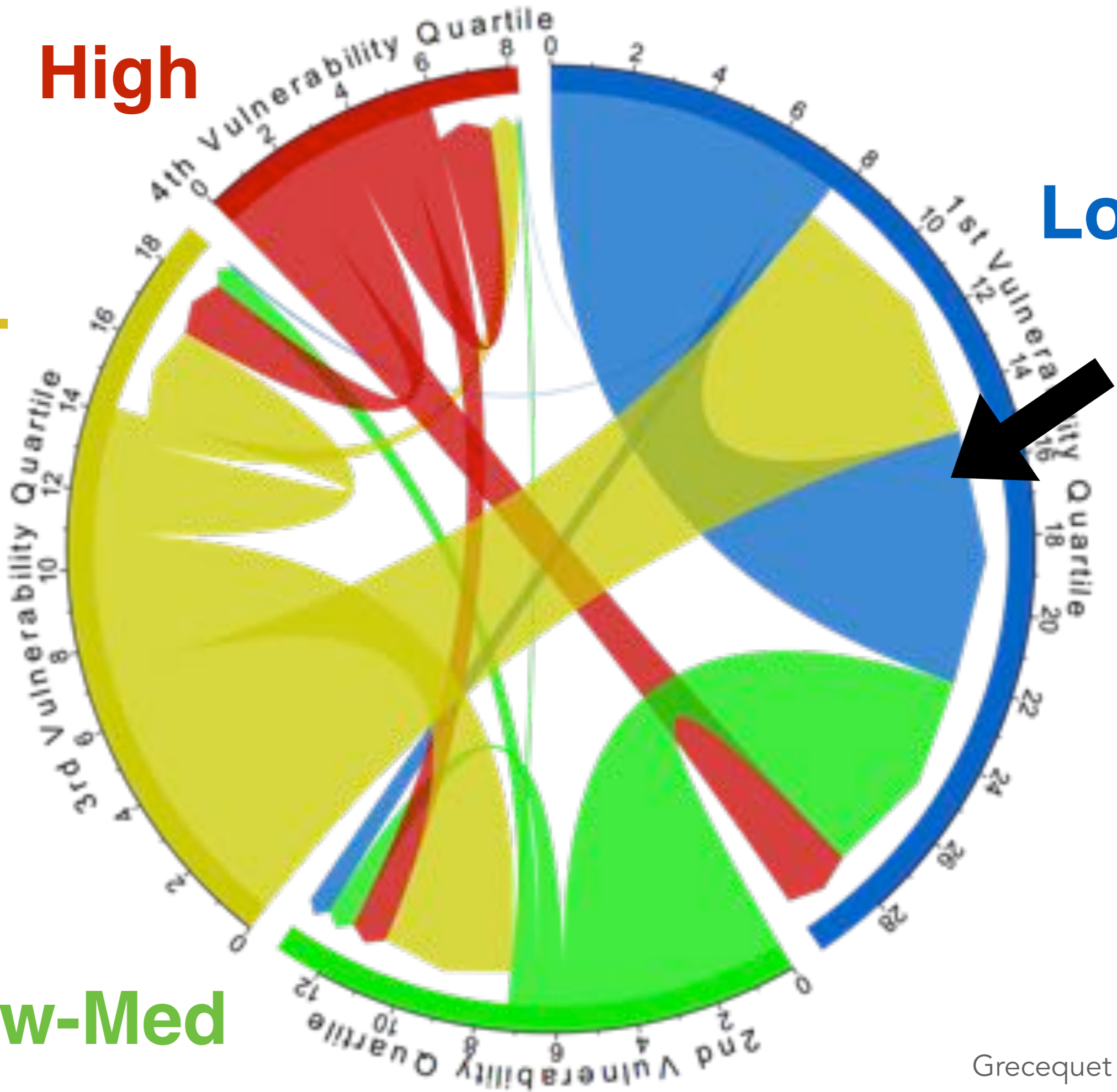


High

Low

High-Med

Low-Med

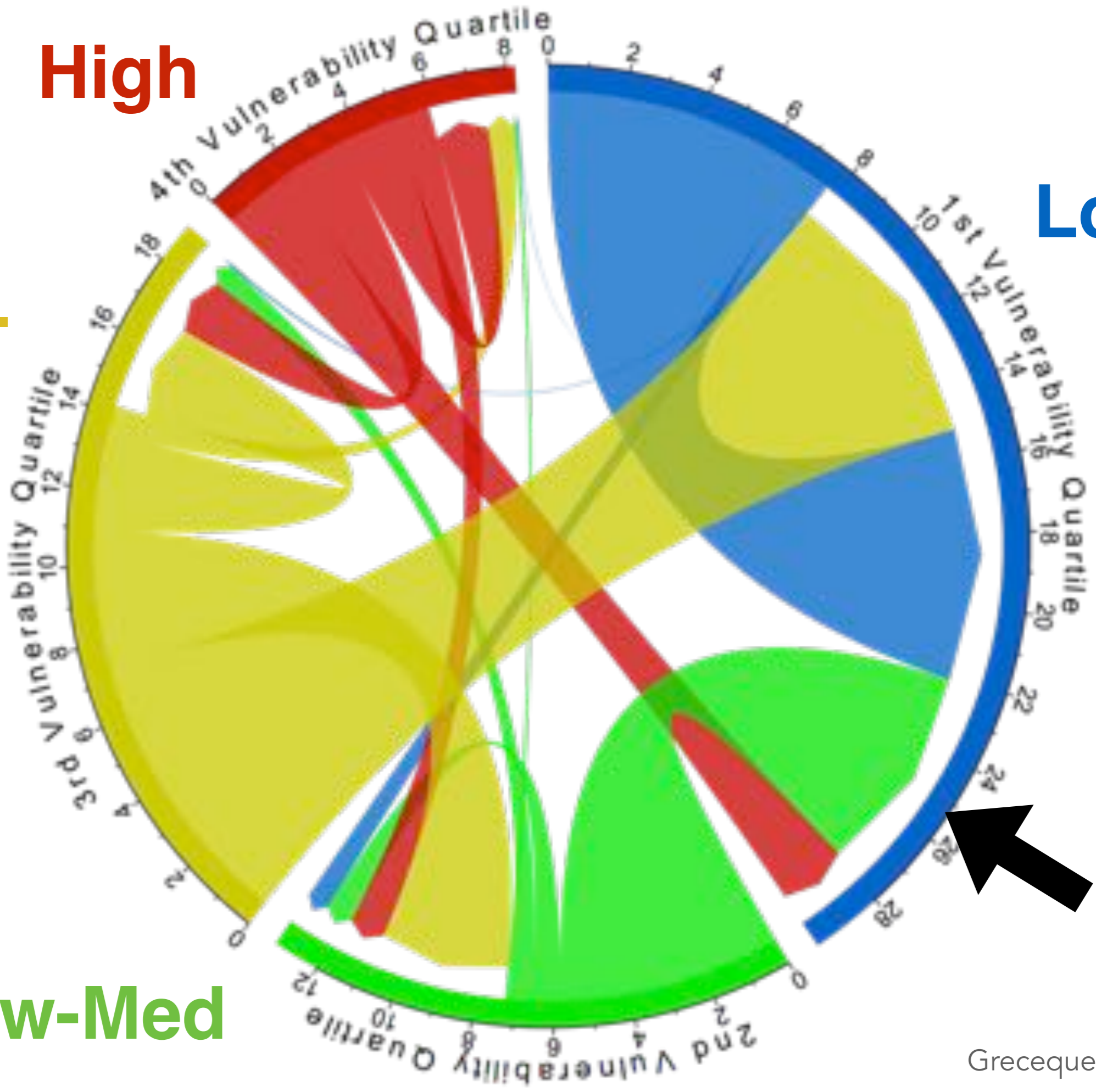


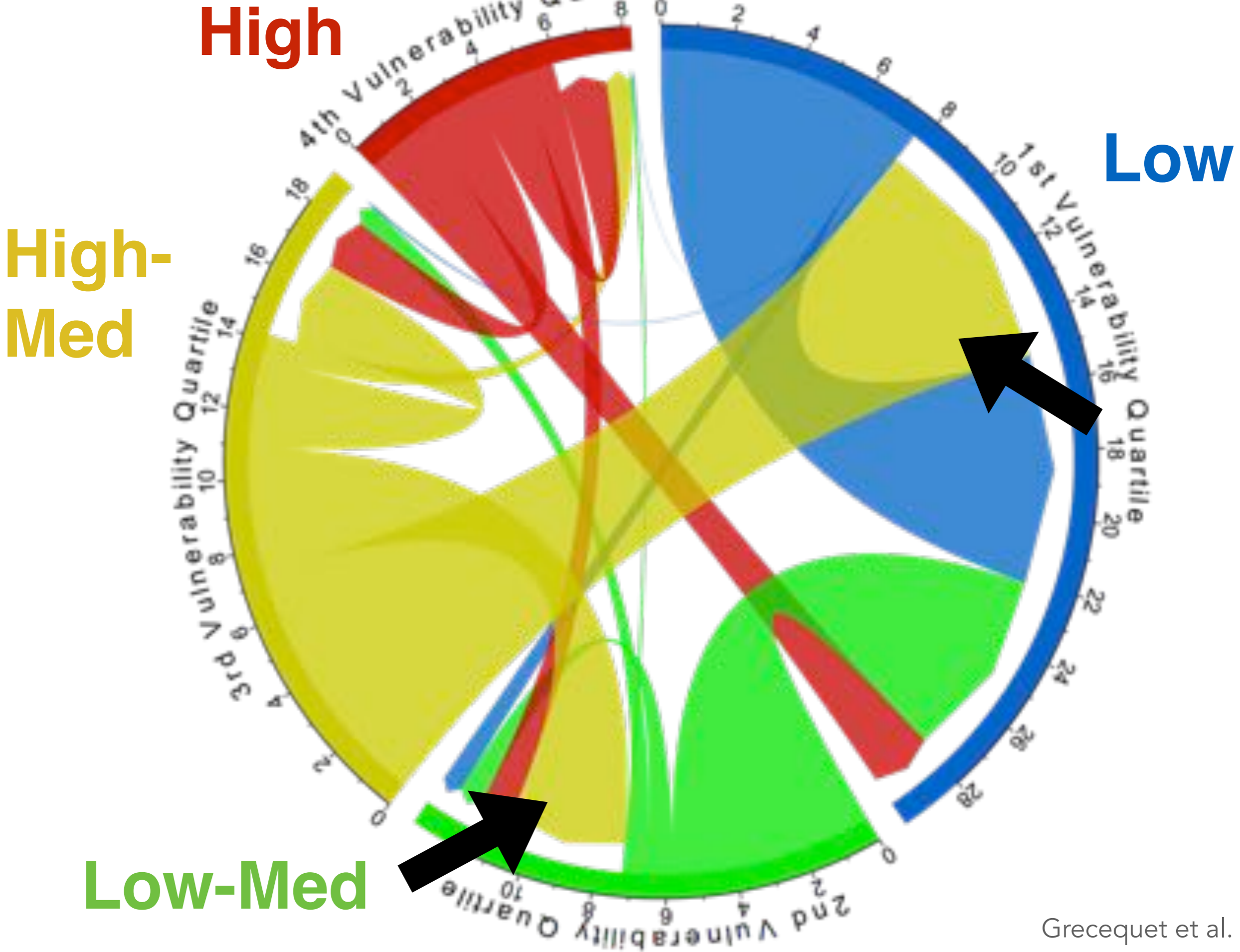
High

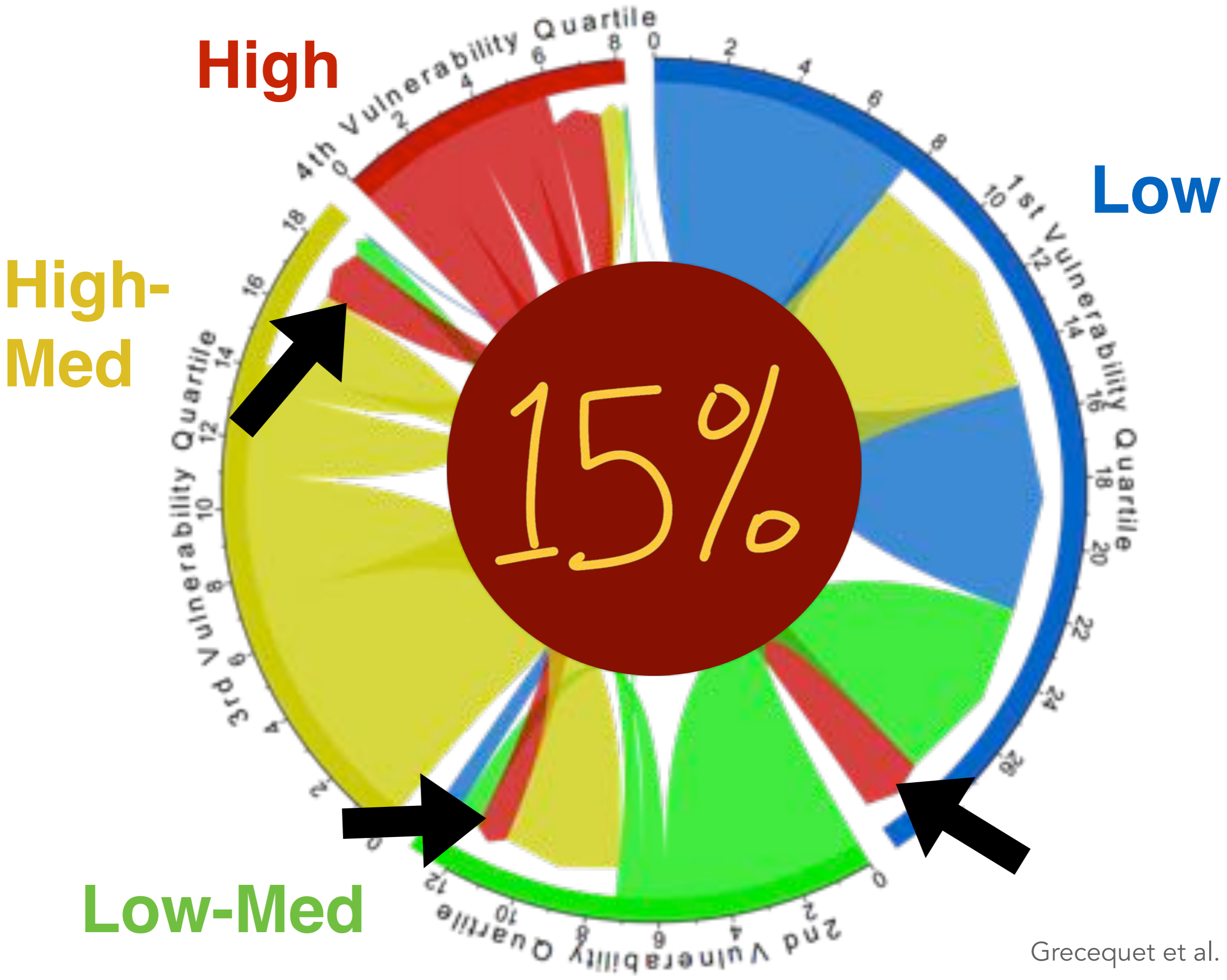
Low

High-Med

Low-Med







Managed relocation

Intervention to reduce negative effects of climate change

Intentional movement of species from current range to where predicted to live in the future.



A Hunt for Seeds to Save Species, Perhaps by Helping Them Move

By ANNE RAVER

CHICAGO — Fisher's thistle, whose fuzzy leaves and creamy pink puffs once thrived in the sand dunes along several of the Great Lakes, was driven by development, drought and weevils into virtual extinction from the shores of Lake Michigan decades ago.

But in the 1990s, seeds collected from different parts of the thistle's range were grown at the Chicago Botanic Garden and planted with the help of the Morton Arboretum along the lake, in Illinois State Beach Park, north of Chicago near the Wisconsin state line. The plants from Indiana's dunes to the south are doing well; the plants that had come from the north are failing.

With those mixed results in mind, scientists from the botanic garden are seeding teams out across the Midwest and West to the Rocky Mountains and Great Basin to collect seeds from different populations of 1,500 prairie species by 2015, and from 3,000 species by 2020. The goal is to preserve the species and, depending on changes in climate, perhaps even help species that generally grow near one another to migrate to a new range.

"In 50 to 100 years, because habitats or climates are so altered, we might end up trying to move species in a restoration context in assemblages of species," said Pat Vitt, a conservation scientist and curator of the Dixon National Tallgrass Prairie Seed Bank at the botanic garden.

The garden is seeking permits to test the concept with the thistle, by pushing it into new, colder territory along the shores of Lake Ontario. "It may be the best test case for moving an individual species outside its range," Dr. Vitt said.

But assisted migration, as it is called, is a hotly debated issue. On one side are those like the botanic garden scientists, who argue that the risks are better than doing nothing.

"We recognize that climate change is likely to be very rapid and that seeds only disperse a few hundred yards, half a mile at most, naturally," said Kayri Havens, the botanic garden's director of plant science and conservation. "They'll need our help if we want to keep those species alive."

Other scientists argue that tinkering with the consistency of habitats is essent-



FLOWERING Native plants like black-eyed Susans are growing in what had been a vacant Chicago lot.

charge."

The American beech, for example, was so rare during the ice age that it is rarely found in fossils. "It may have been one of those rare and unusual species we think about saving with approaches like assisted migration," Dr. McLachlan said. Now, the beech is so abundant in Eastern forests, he said, it is shading out "almost all other species."

Dr. McLachlan and other scientists have formed a working group on managed relocation, financed by the National Science Foundation and the Cedar Tree Foundation, to open up the discussion to citizens, economists, natural resource managers and policy makers.

While the debate proceeds, scientists at the botanic garden are building the seed collection and assessing the adaptability of different populations of species.

of September, they moved collections of 800 Midwestern species — some made up of 300,000 seeds — from their old home in four large freezers, hardly different from the kind a large family might use to store home-grown produce and a side of beef.

"The first time I walked in here, I started to cry," Dr. Vitt said. "I know what it's like to see something you've done in the

Is it wise or foolish to assist with the migration of plants?

... It's the most important conservation work we can be doing." The nearby effort is part of a Bureau

Seeds of Success, started in 2001 in response to a Congressional mandate to plant native seed in restoring public lands destroyed by wildfire, began its far more ambitious initiative in June 2008.

A consortium of botanic gardens and other institutions have sent 65 teams across the country, which so far have collected groupings of 3,200 species.

"We hope to collect 20 populations across the species' range so we can get 95 percent of the genetic diversity of the species," said Peggy Orvell, the plant conservation program manager at the bureau. "Because frankly, we don't know what it is we're going to need when we're talking restoration in light of climate change. It's going to be one big experiment."

Seeds of Success needs one collection of seeds from the 100 million seed

The Dixon seed bank at the Chicago Botanic Garden houses not only species from the tallgrass prairie, but also natives of the bogs, dunes and other ecosystems in the prairie region. It also includes the working collections of species singled out for restoration.

"In the Midwest, we have about 200 that are going to be very important," Dr. Havens said. "These are the matrix species, the bread-and-butter species that can be used in restoration after disturbance to really stabilize the community."

Climate models all show temperatures rising, but they do not agree on the prairie's future climate.

"Some models show us with more Virginia-like ecosystems, some say more like Texas," Dr. Havens said.

In a paper to be published in the journal *Biological Conservation* and available now online, Dr. Vitt, Dr. Havens and three other scientists at the botanic garden outline a framework for assisted migration, calling first for a globally unified seed banking strategy, which involves collecting genetically diverse populations of each species, accompanied by provenance data like GPS coordinates, soil type and the structure of the surrounding plant community.

They also propose how to predict where species can be relocated. The scientists are just beginning to test their theories in seven climate change gardens planted this fall across the country. Each contains genetically identical clones of plants grown from seed collected in four hardiness zones (4, 5, 6 and 7). Three sites are in the Chicago area, with the others in Boston; Chapel Hill, N.C.; Seattle; and Washington.

Students and volunteers will collect data on the species, and can compare their gardens with others through a webcam system. "If plants grown from seed collected in Zone 4, 5 or 6 can't withstand Texas conditions," Dr. Havens said, "that's a good sign they're going to become extinct here, if there's no way for them to migrate on their own or human-assisted."

Collecting all the native species in the United States, as well as developing restoration techniques and growing huge amounts of seed will take about 10 years and cost about \$500 million, Dr. Havens said — a cost that she argues is well worth it.

The 100 million seed bank is expected to

Planning for migration



Middle Eastern migrants to Europe

- Identify regions with fastest change
- Identify climate refugia
- Plan parks & reserves to receive migrants
- Build corridors
- Facilitate migration

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habitat conservation



restoration







25% = 2°

100% = 5°







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~hopeful future~



prosperity

prosperity
freedom

prosperity

freedom

Stewardship



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Thank you!