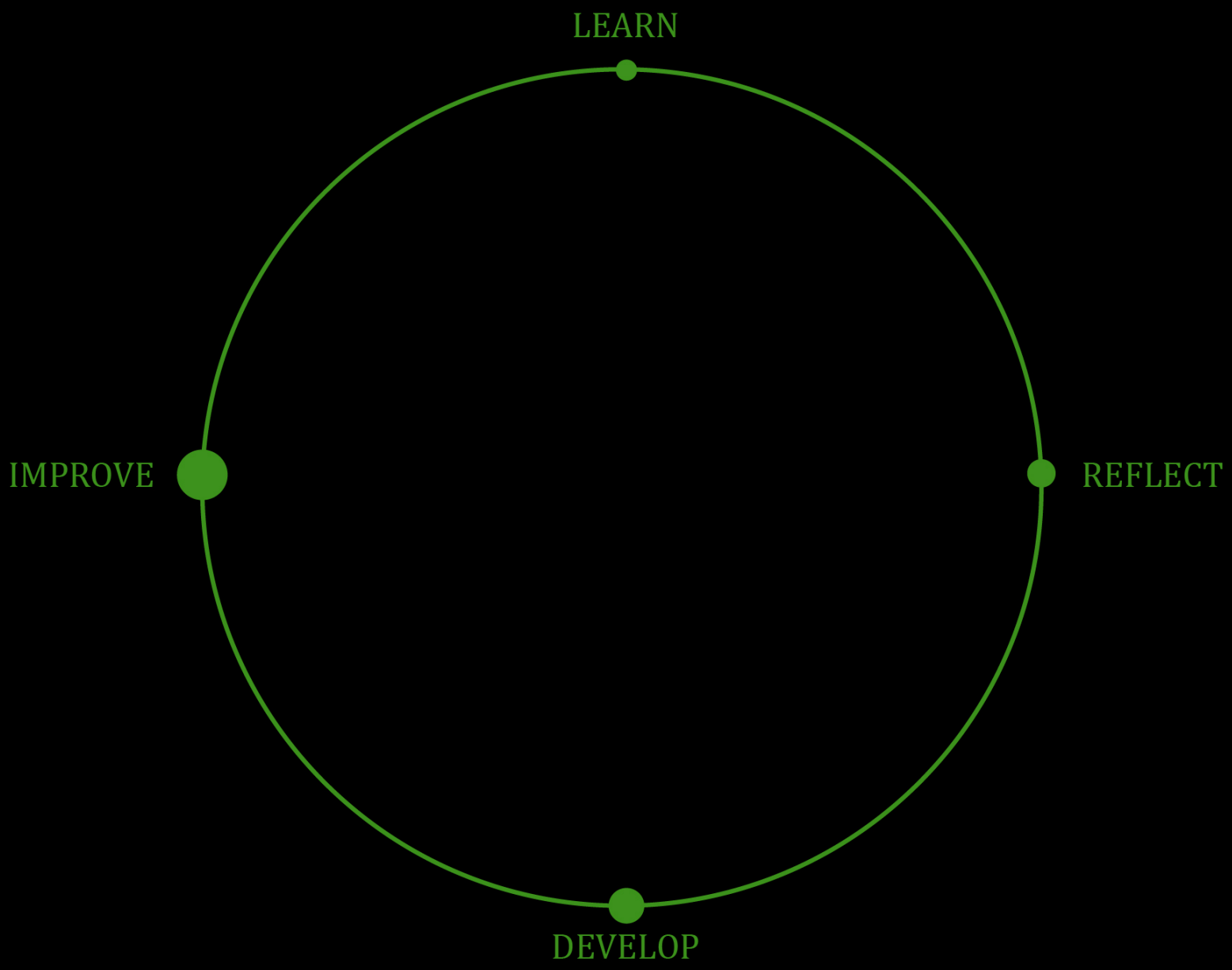
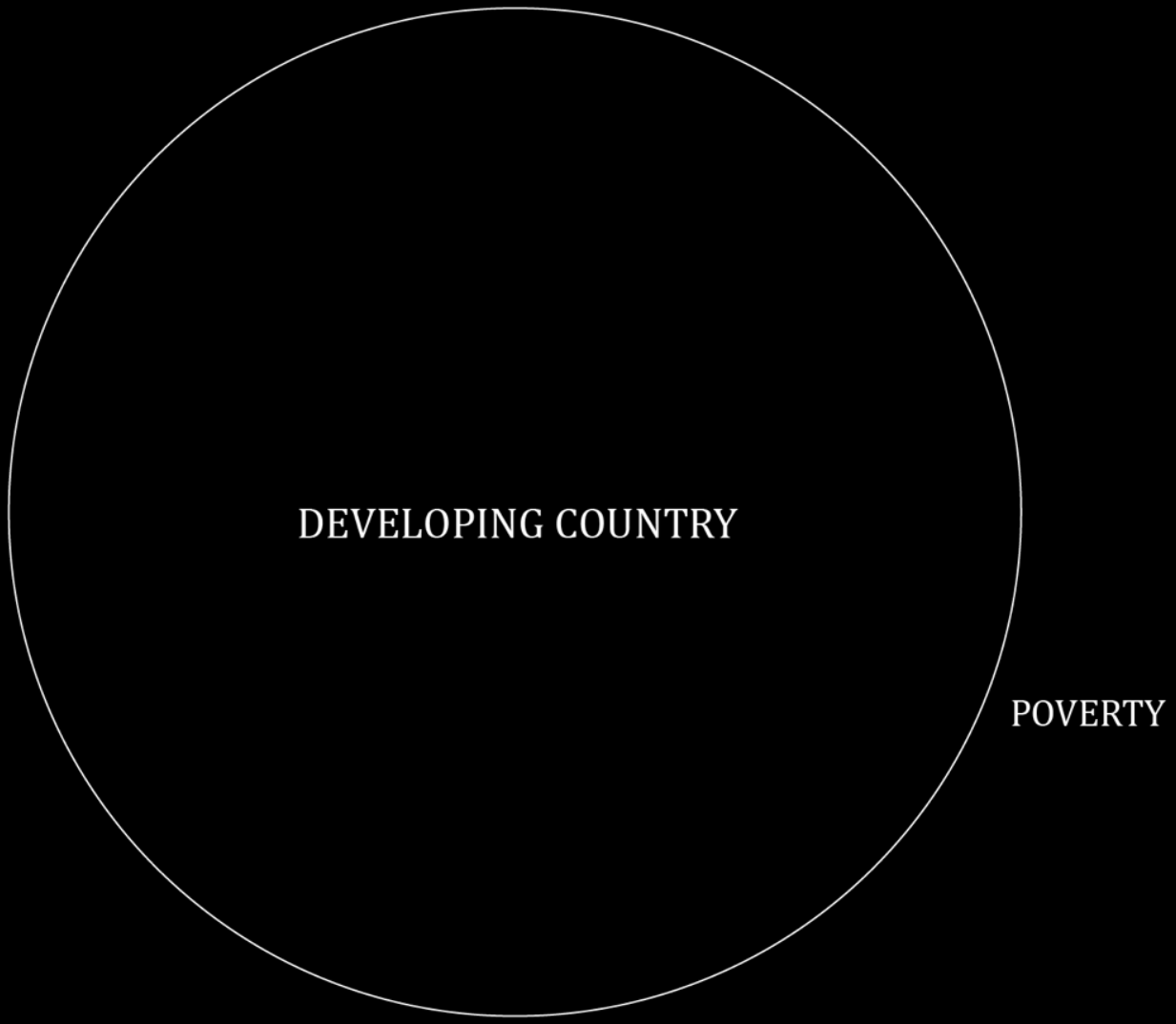
LIVING ROOT BRIDGE ECOSYSTEMS

sanjeev shankar

Oxford Centre for Tropical Forests
November 10th 2016


LEARN
REFLECT
DEVELOP
IMPROVE


DEVELOPING COUNTRY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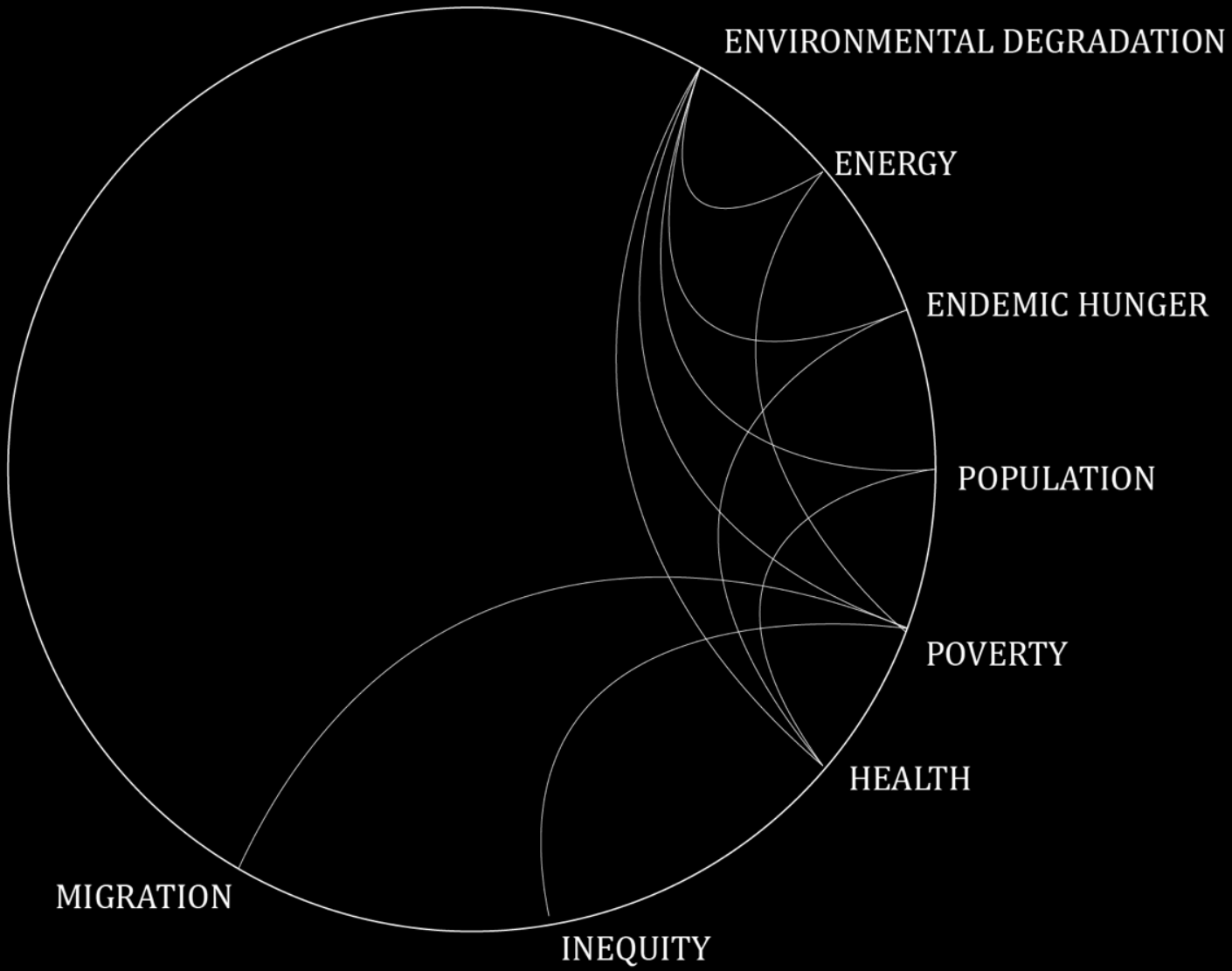
POVERTY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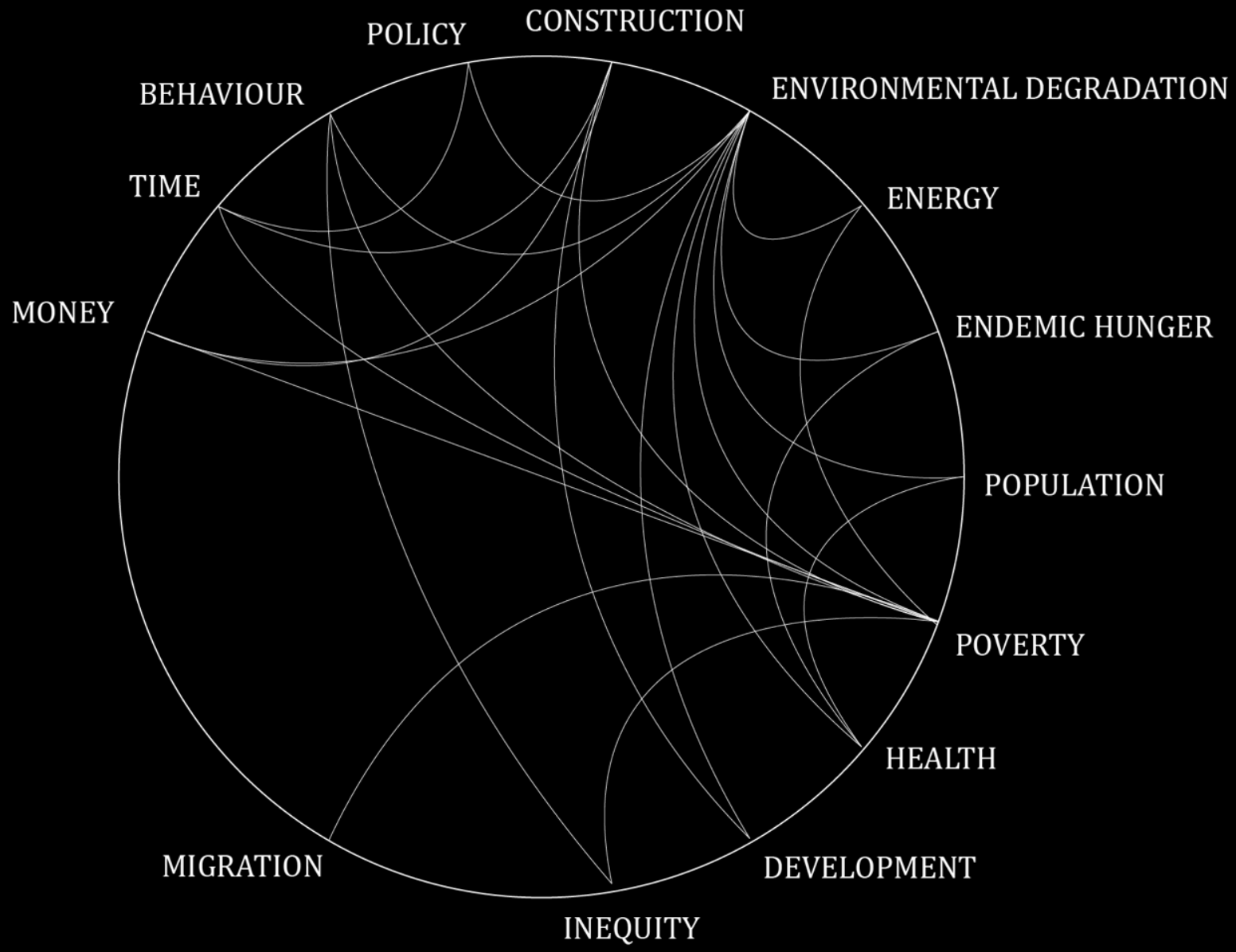
ENERGY
ENDEMIC HUNGER
POPULATION
POVERTY
HEALTH
INEQUITY
MIGRATION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CONSTRUCTION
BEHAVIOUR
ENVIRONMENTAL DEGRADATION
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ENERGY
MONEY
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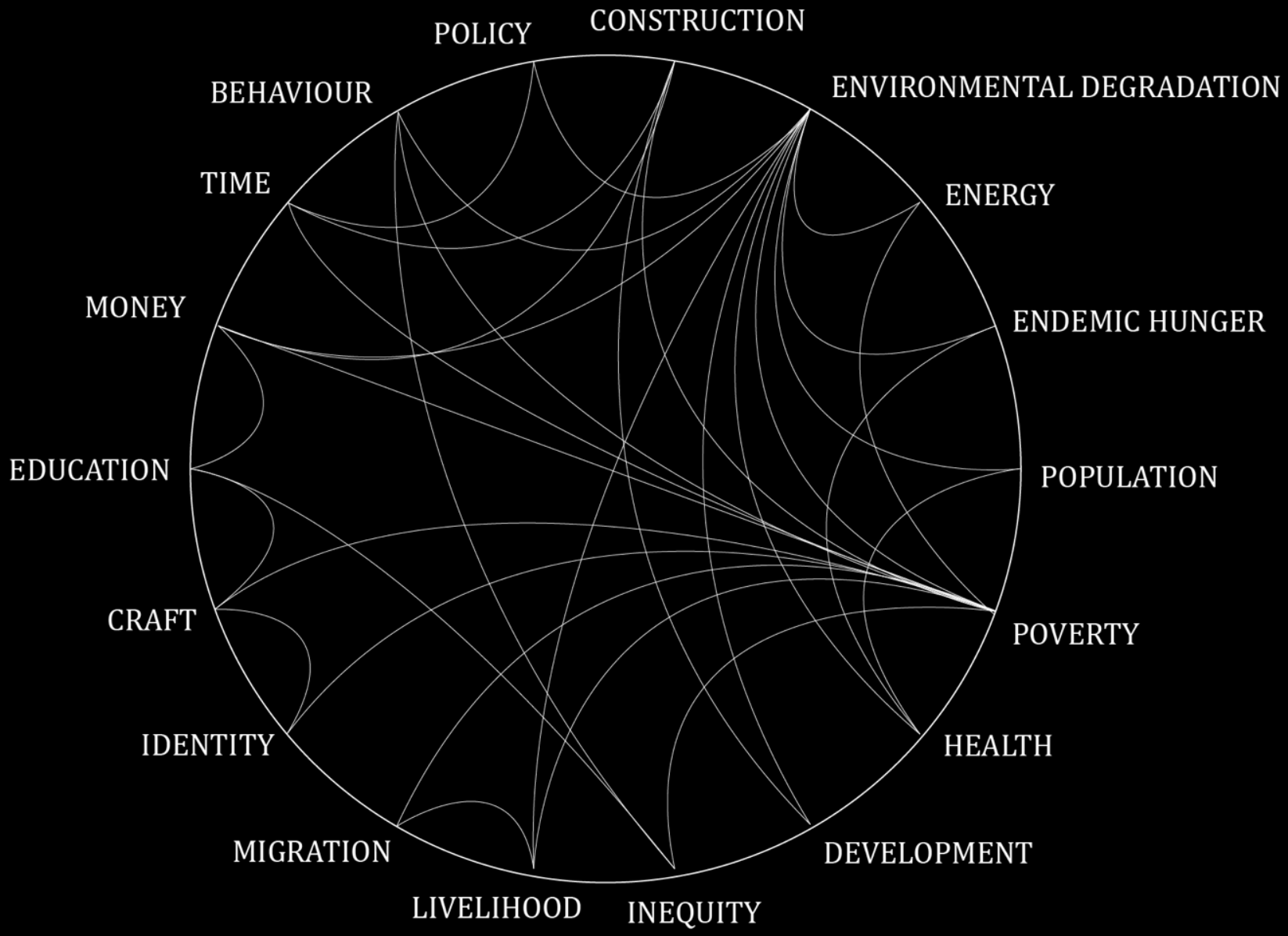
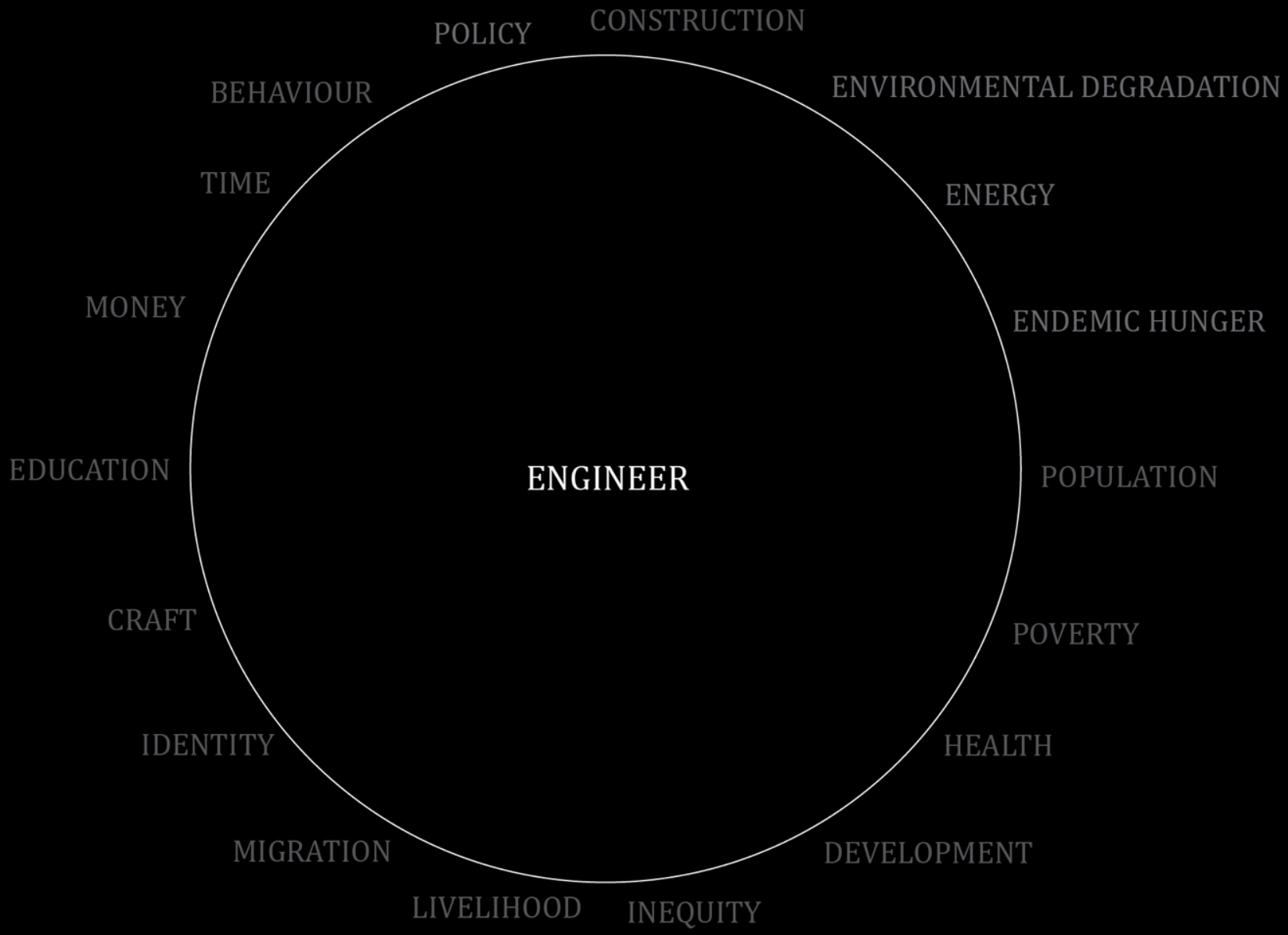
POPULATION
POVERTY
HEALTH
MIGRATION
DEVELOPMENT
INEQUITY


POLICY
CONSTRUCTION
BEHAVIOUR
ENVIRONMENTAL DEGRADATION
TIME
ENERGY
MONEY
ENDEMIC HUNGER
EDUCATION
POPULATION
CRAFT
POVERTY
IDENTITY
HEALTH
MIGRATION
DEVELOPMENT
LIVELIHOOD
INEQUITY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MONEY
ENDEMIC HUNGER
EDUCATION
ENGINEER
POPULATION
CRAFT
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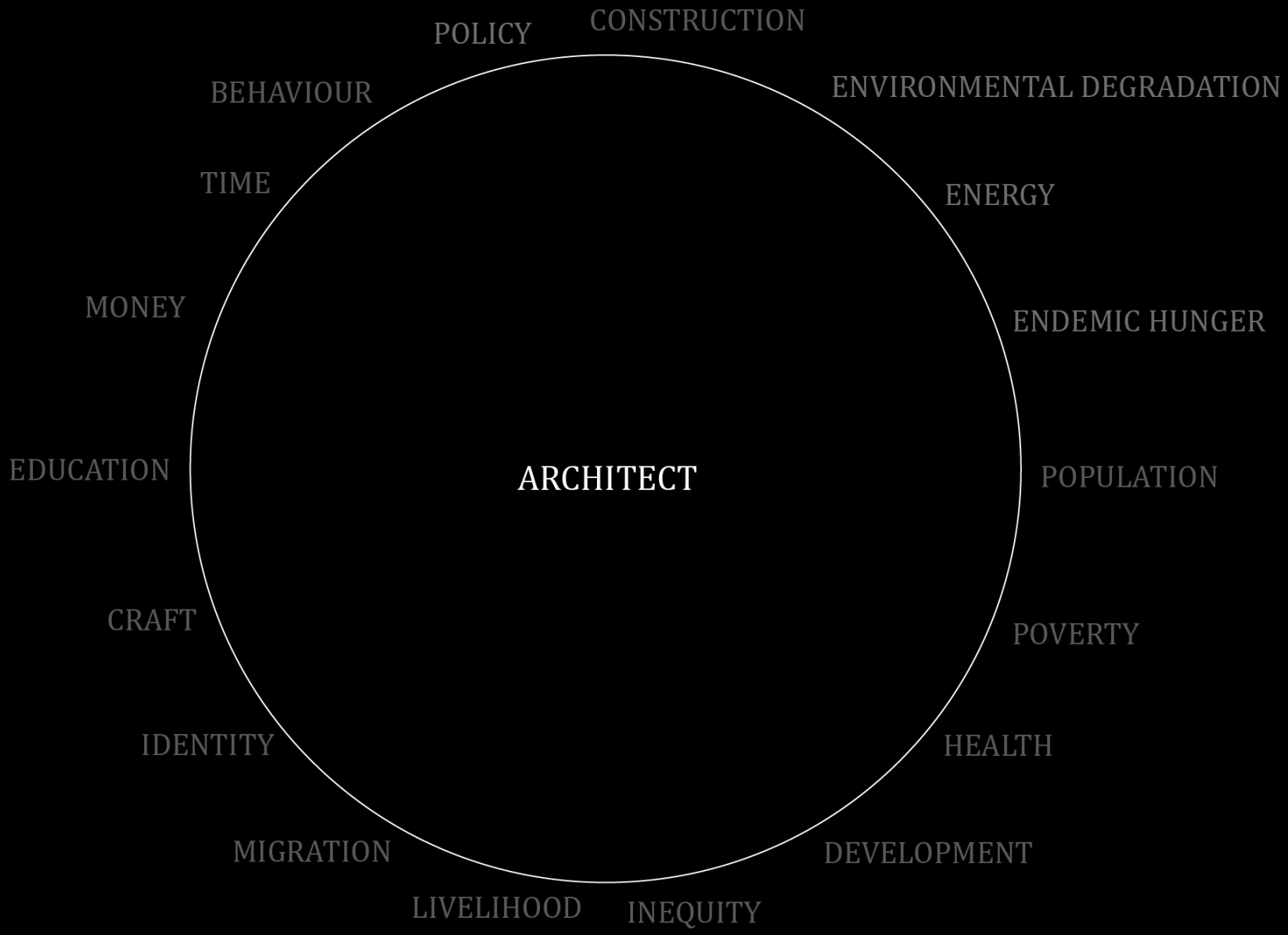
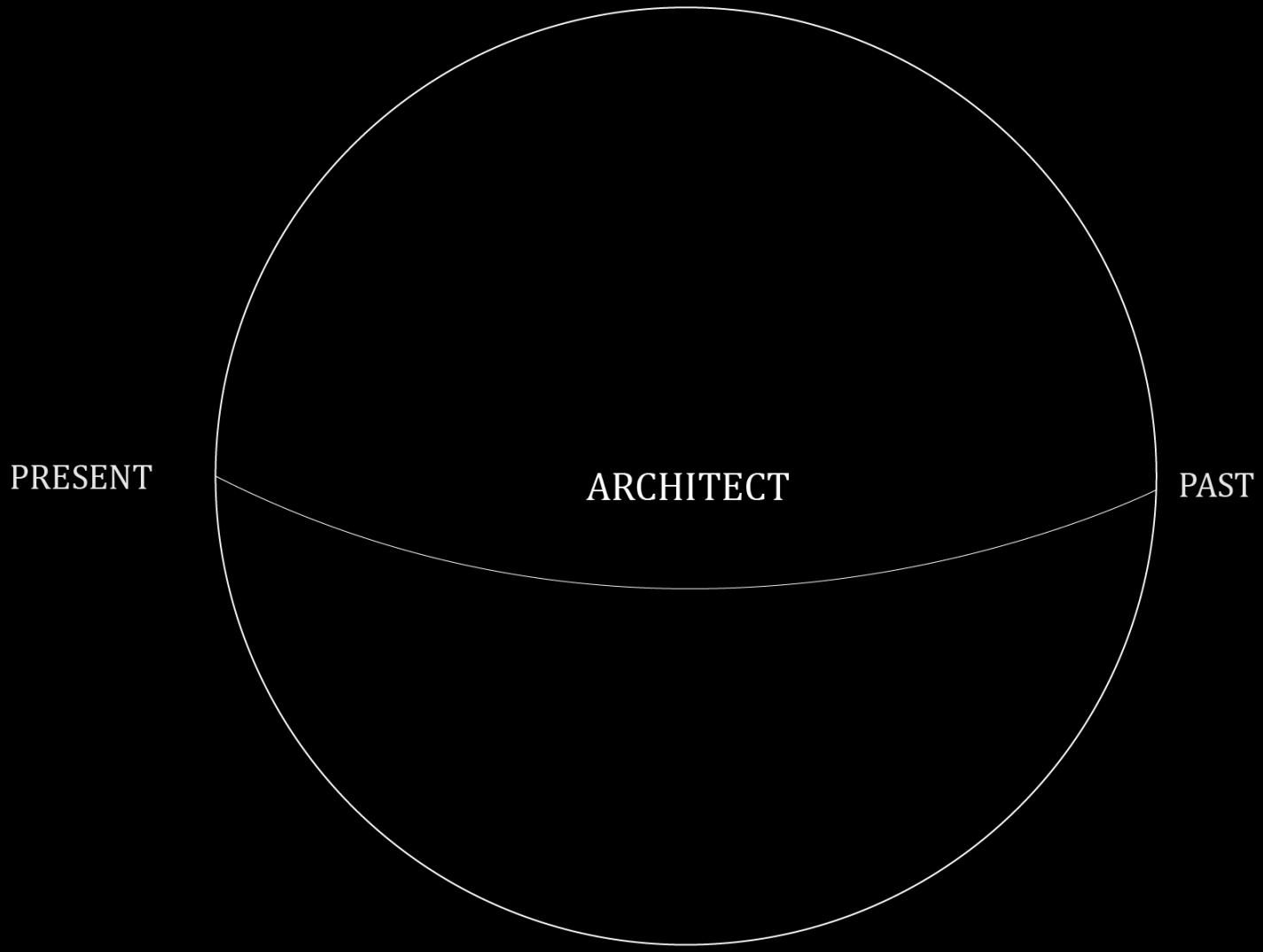
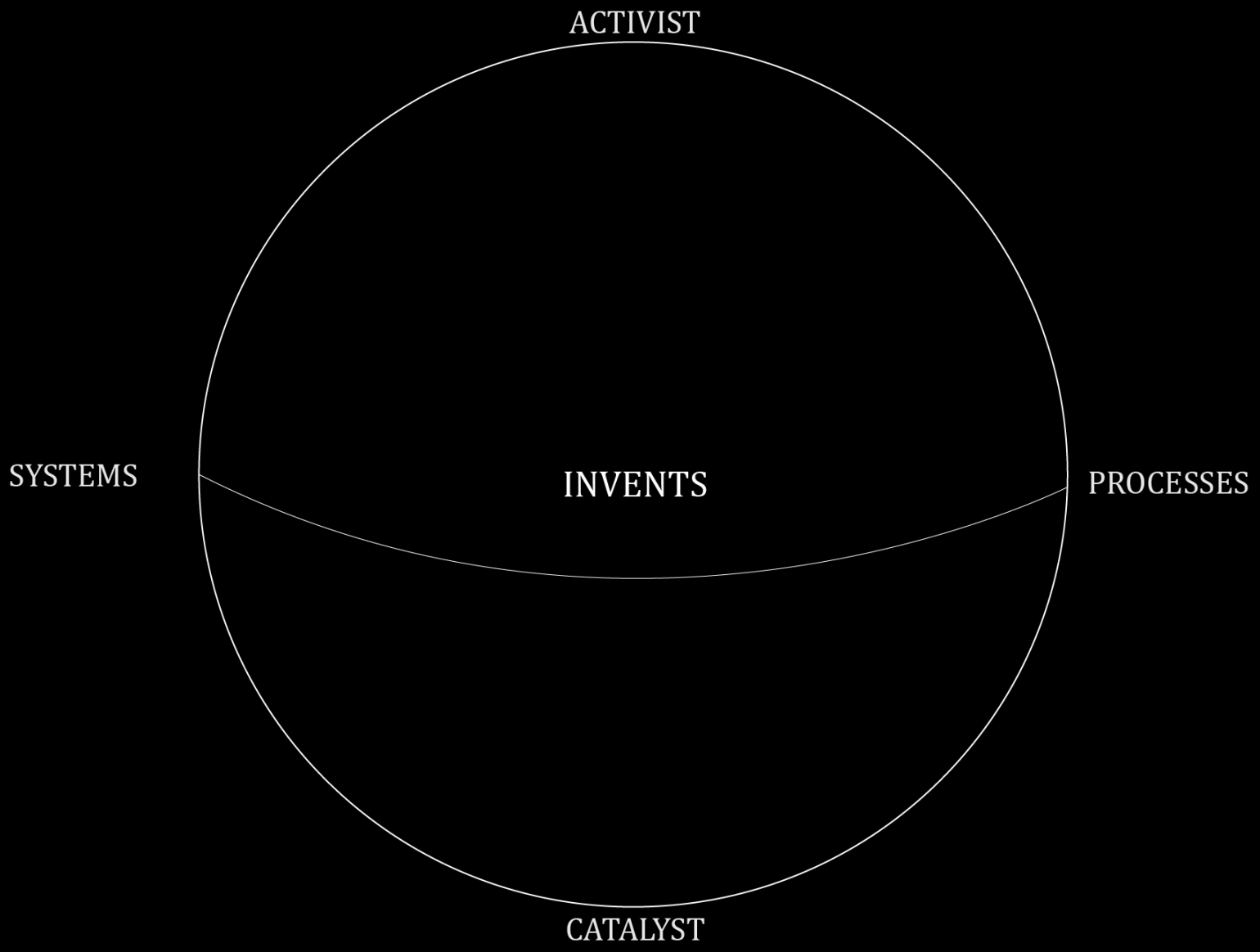
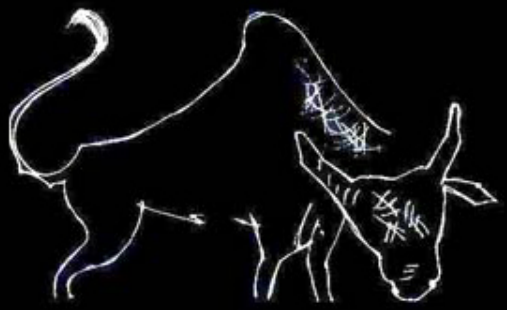
IDENTITY
HEALTH
MIGRATION
DEVELOPMENT
LIVELIHOOD
INEQUITY


POLICY
CONSTRUCTION
BEHAVIOUR
ENVIRONMENTAL DEGRADATION
TIME
ENERGY
MONEY
ENDEMIC HUNGER
EDUCATION
ARCHITECT
POPULATION
CRAFT
POVERTY
IDENTITY
HEALTH
MIGRATION
DEVELOPMENT
LIVELIHOOD
INEQUITY

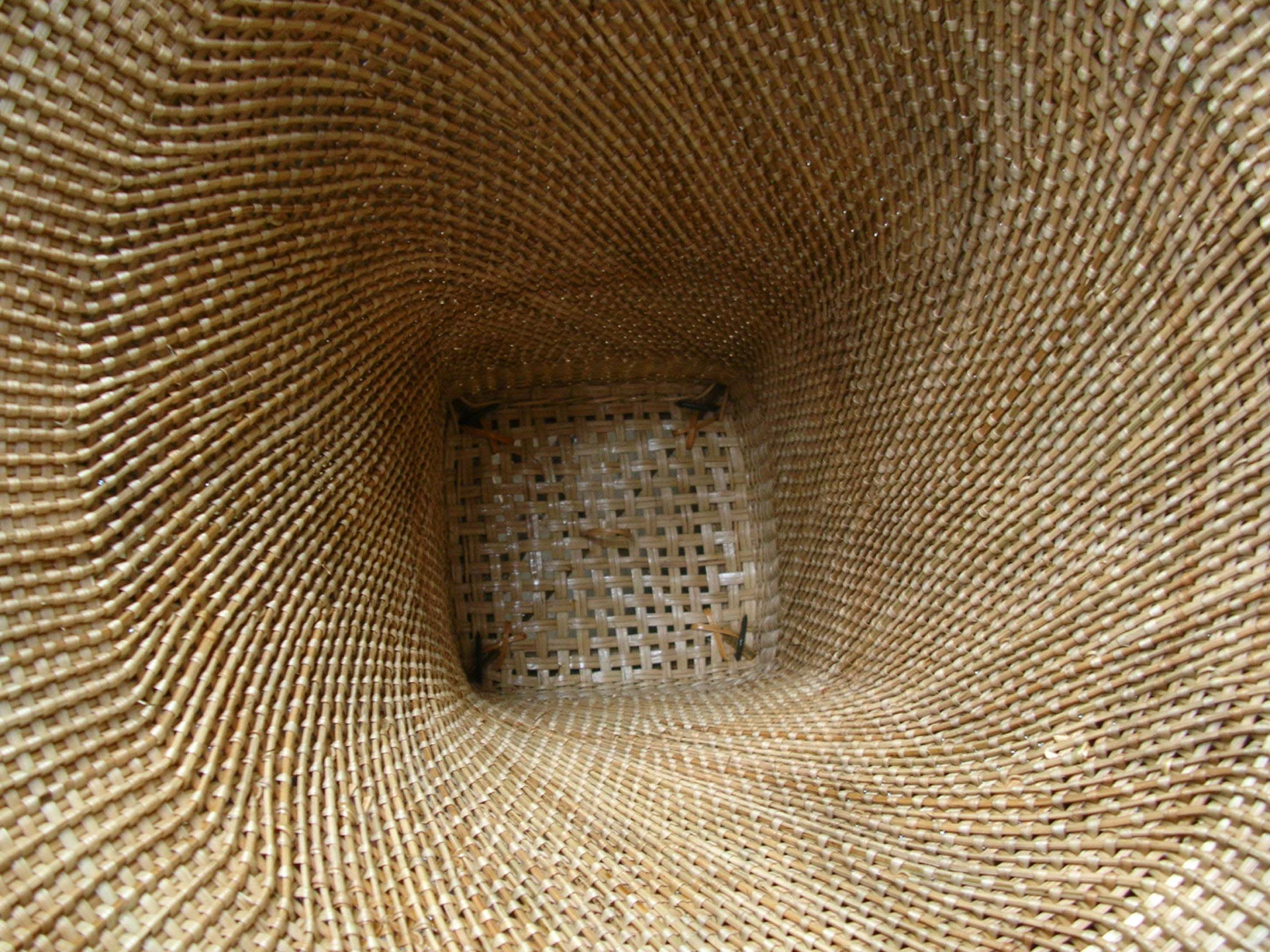

PRESENT
ARCHITECT
PAST


ACTIVIST
SYSTEMS
INVENTS
PROCESSES
CATALYST


SEE
VALUE
IMAGINE




CHINA
NAGALAND
INDIA
BURMA

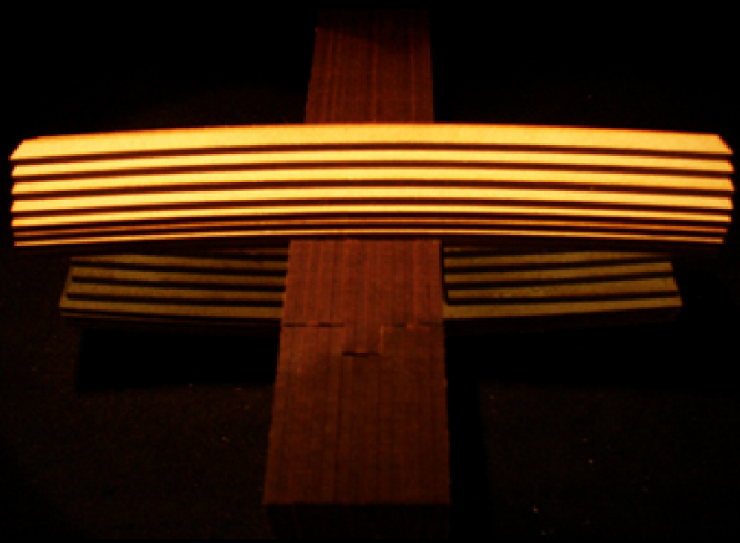


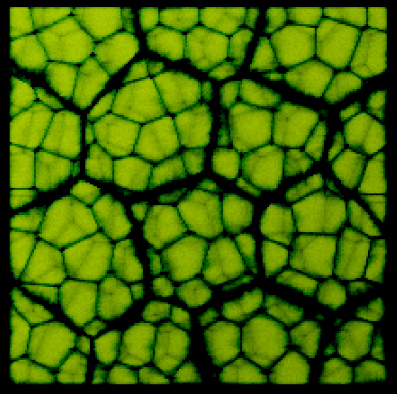



RVT
Super
GOLD
VEGETABLE REFINED
OIL
Packed & Marketed By :
R.V. TRADING CO.
15
KG

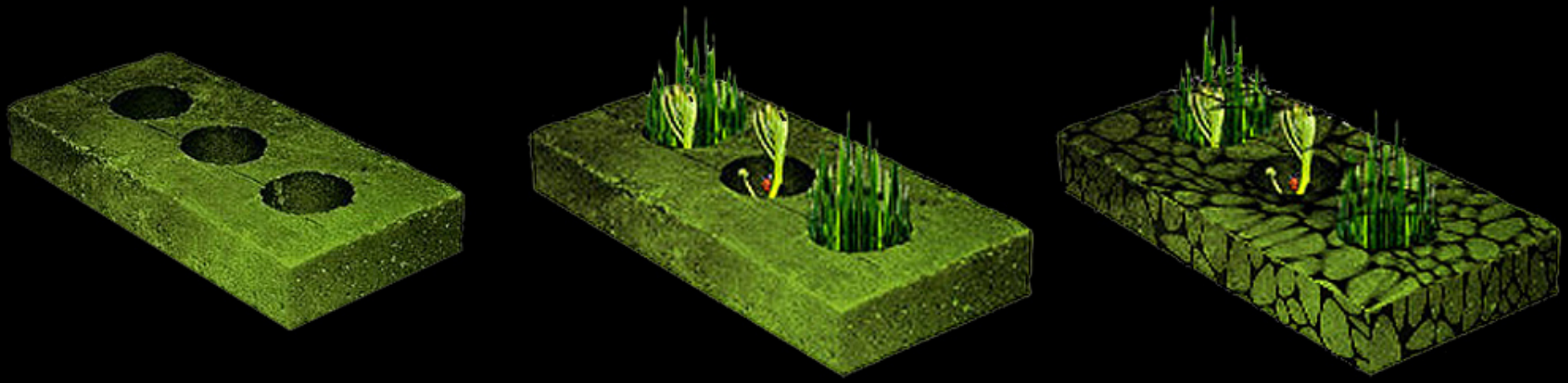

SANS
CHOLESTEROL
NO CHOLESTEROL
SULTAN
BRAND
100% EXTRA VIRGIN
OLIVE OIL
HUILE
D'OLIVE
EXTRA VIERGE 100 %
FIRST PRESS COLD PRESS
Net 128 FL OZ. (1 Gal.) (3.785 Liter)


HAIPAL






SOCIAL
IMPACT
ECONOMIC
ECOLOGICAL



can it ensure forest regeneration and promote good health ?

can it become a host biome for orchids, mushrooms, other epiphytic plants and food for humans ?

can it support 1274 birds and mammal species in 523 genera ?

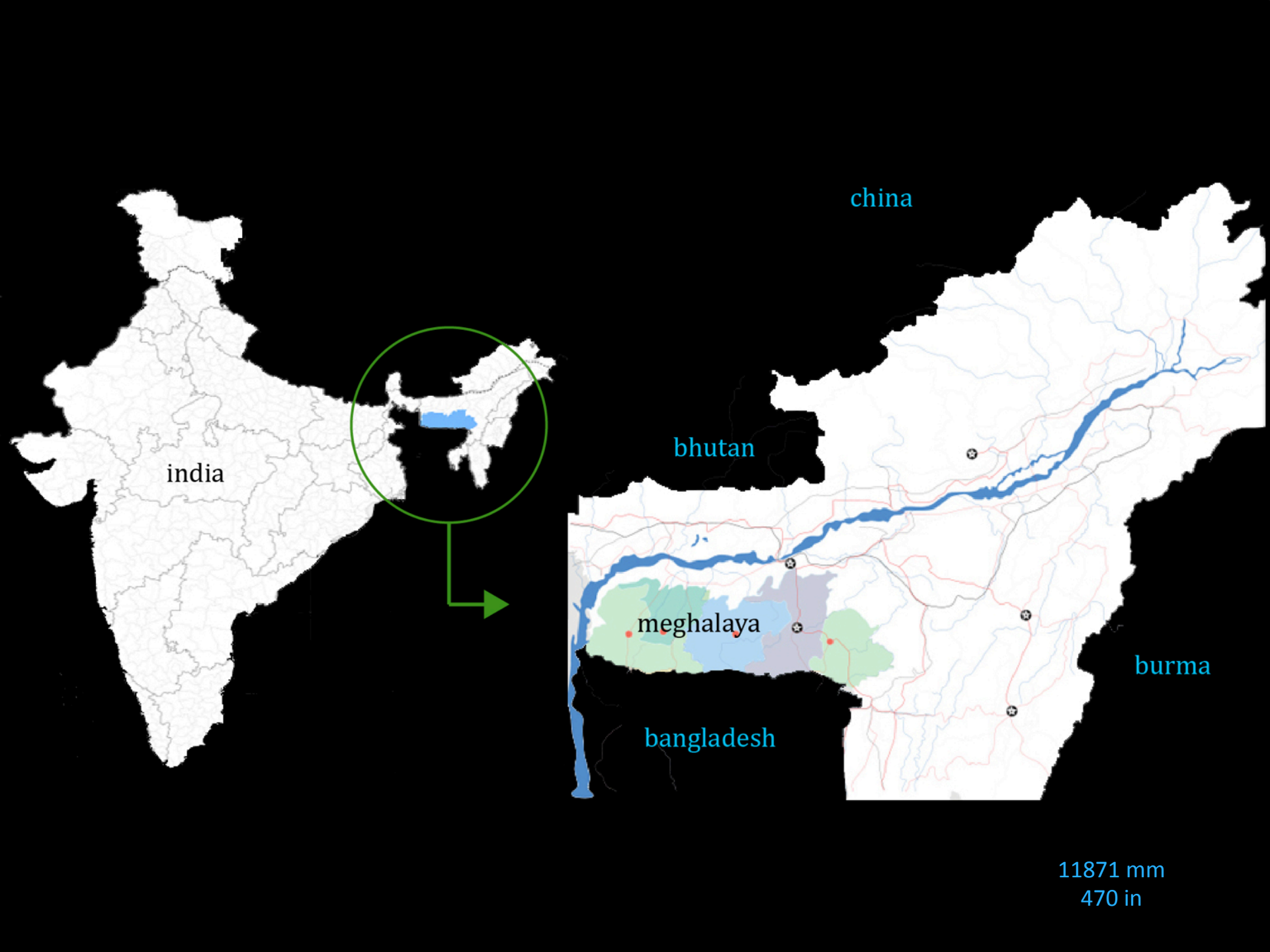
can it demonstrate exceptional robustness under extreme climatic conditions with minimal material and maintenance cost ?

can it nurture indigenous crafts?

can it ensure social justice, equality, compassion, informality and sensitivity ?

LIVING ROOT BRIDGES


jing king jri


china
india
bhutan
meghalaya
burma
bangladesh
11871 mm
470 in

Living root bridges are *Ficus* based ecosystems within dense subtropical moist broadleaf forests of North Easern Indian Himalayas (25° 30' N and 91° 00' E). Ranging in span from15 feet to 250 feet, these bridges are grown by Khasi and Jaintia tribes over a time period of 15 to 30 years, and last for several centuries.

A - height of main tree: 27.40

B - height of young tree - 3.96

C - bottom to top bridge - 3.35

D - river to bottom bridge - 3.35

E - span of top bridge - 23.77

F - span of bottom bridge - 17.67

G - height of hand rail - 1.34

H - height of hand rail - 1.34

all dimensions in meters

Double decker bridge, meghalaya, india (side view)

C - bottom to top bridge - 3.35

G - height of hand rail - 1.34

I - walking path width - 0.8 to 0.9

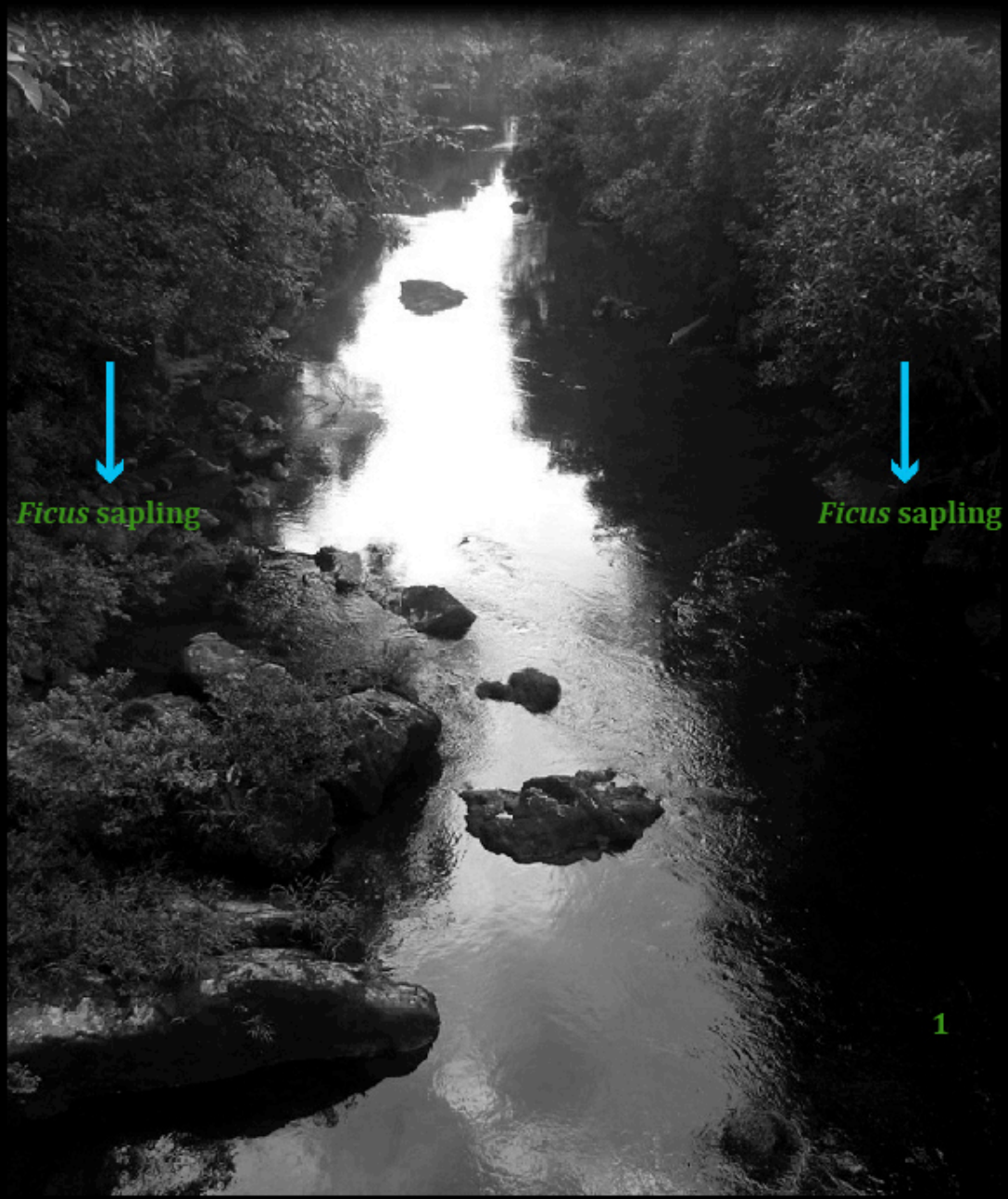
J - width between railing - 1.5 to 1.8

K - walking path width - 0.8 to 1.09

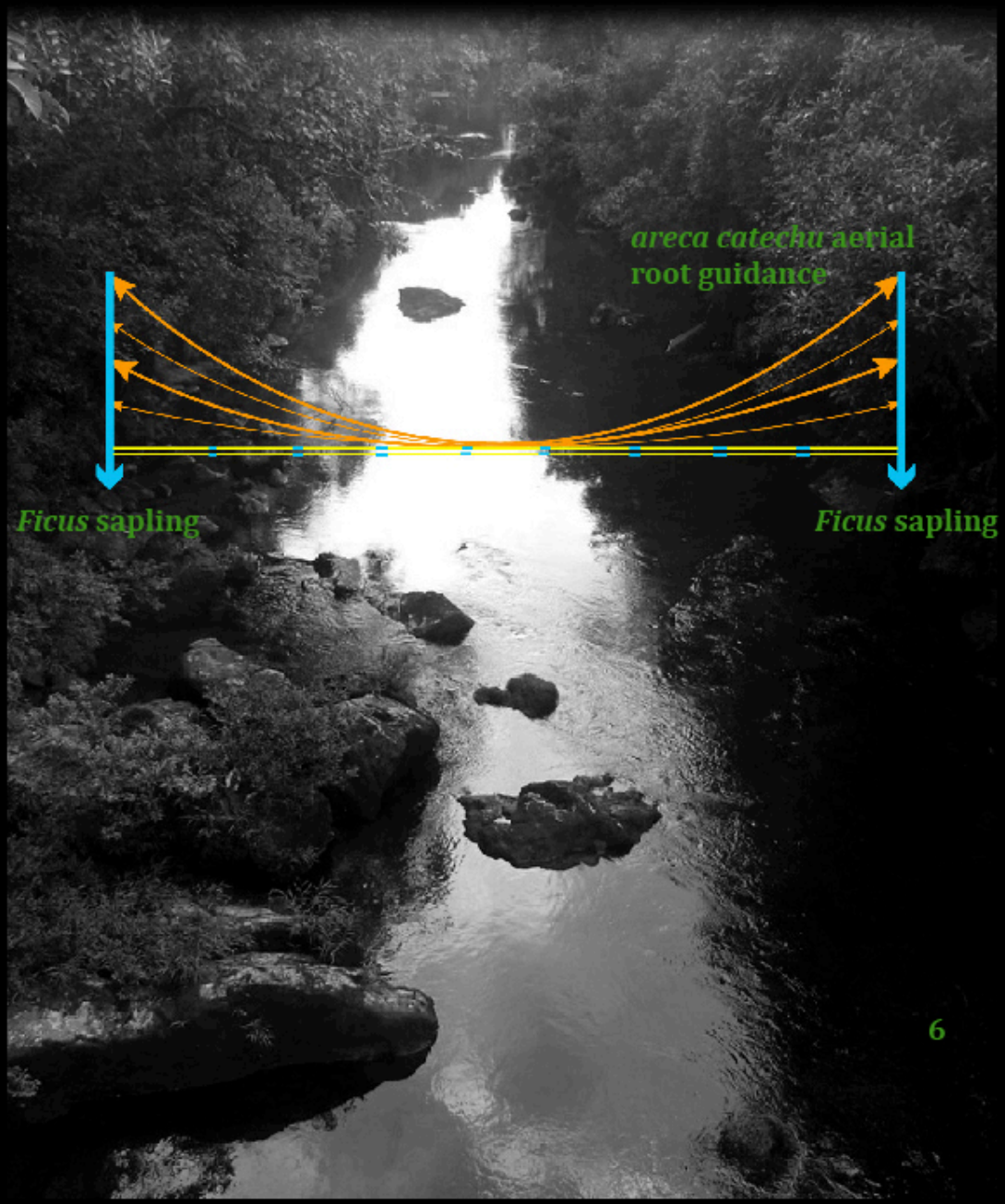
L - width between railing - 1.5 to 1.8

all dimensions in meters

Double decker bridge, nongriat, meghalaya, india (side view close up)


Ficus sapling
Ficus sapling
1

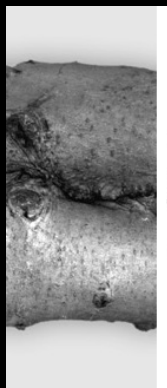

bamboo scaffold
Ficus sapling
Ficus sapling

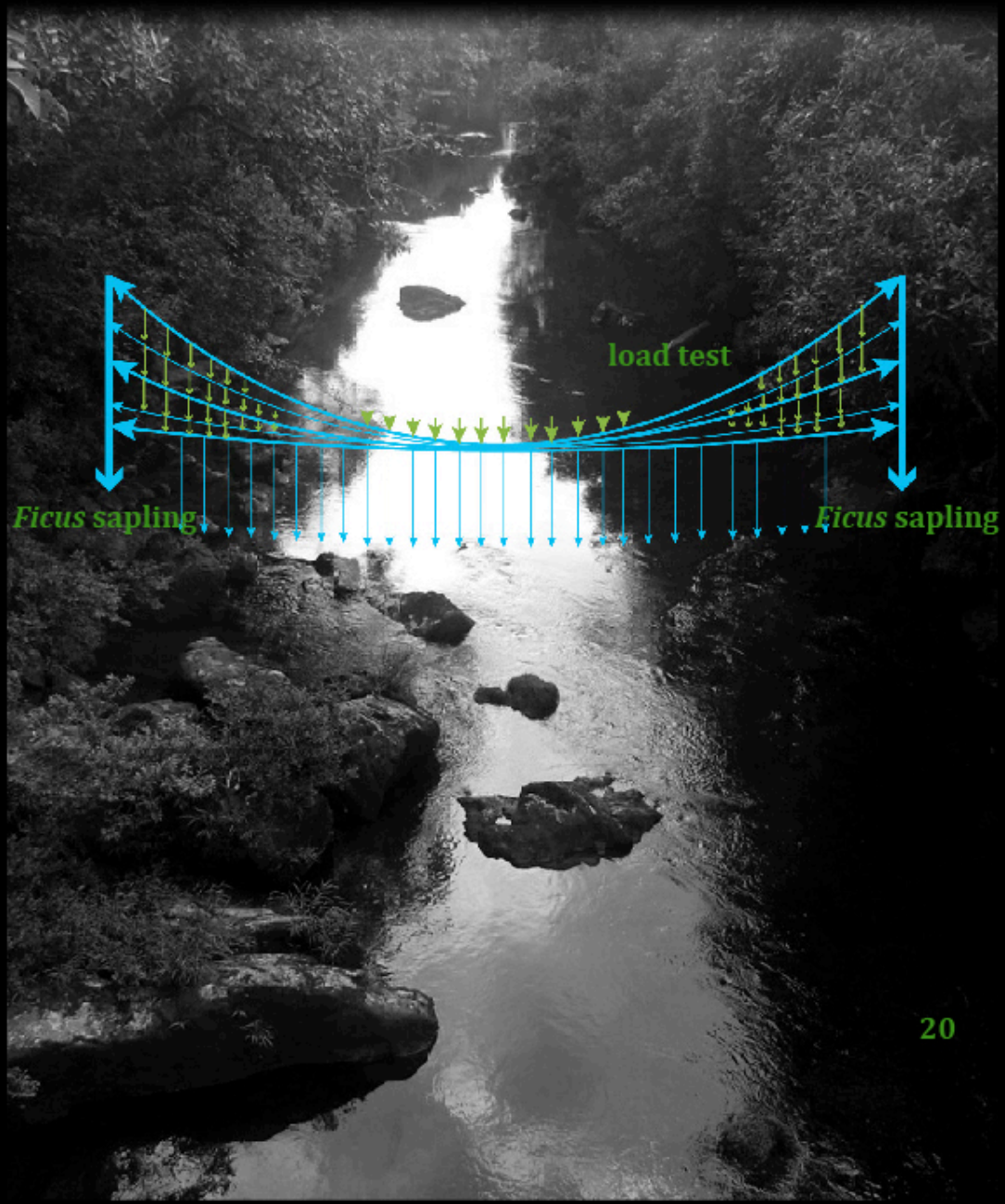

areca catechu aerial root guidance
Ficus sapling
Ficus sapling

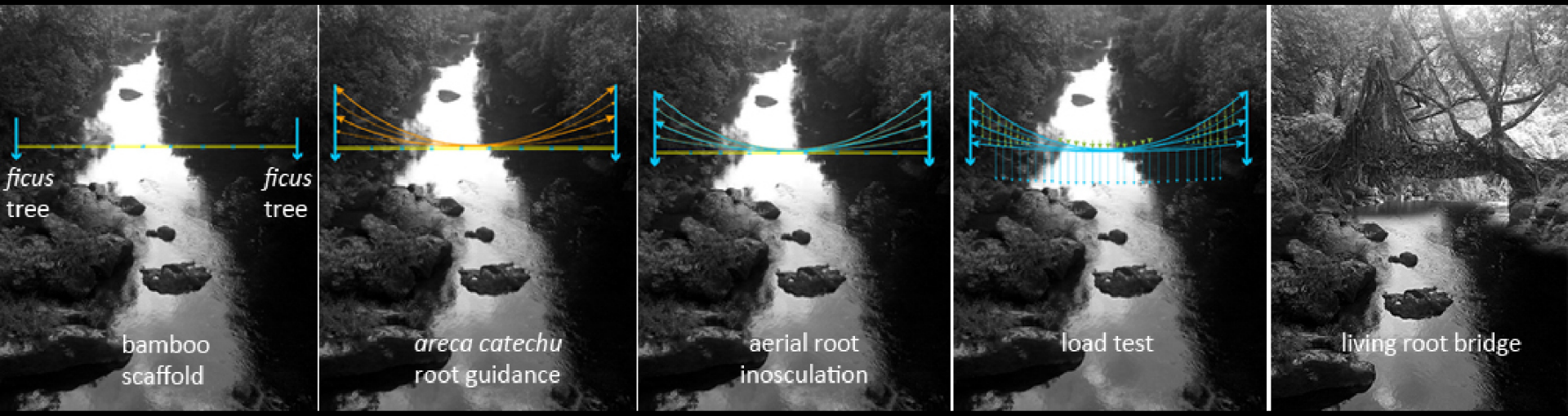
aerial root inosculation

Ficus sapling

Ficus sapling



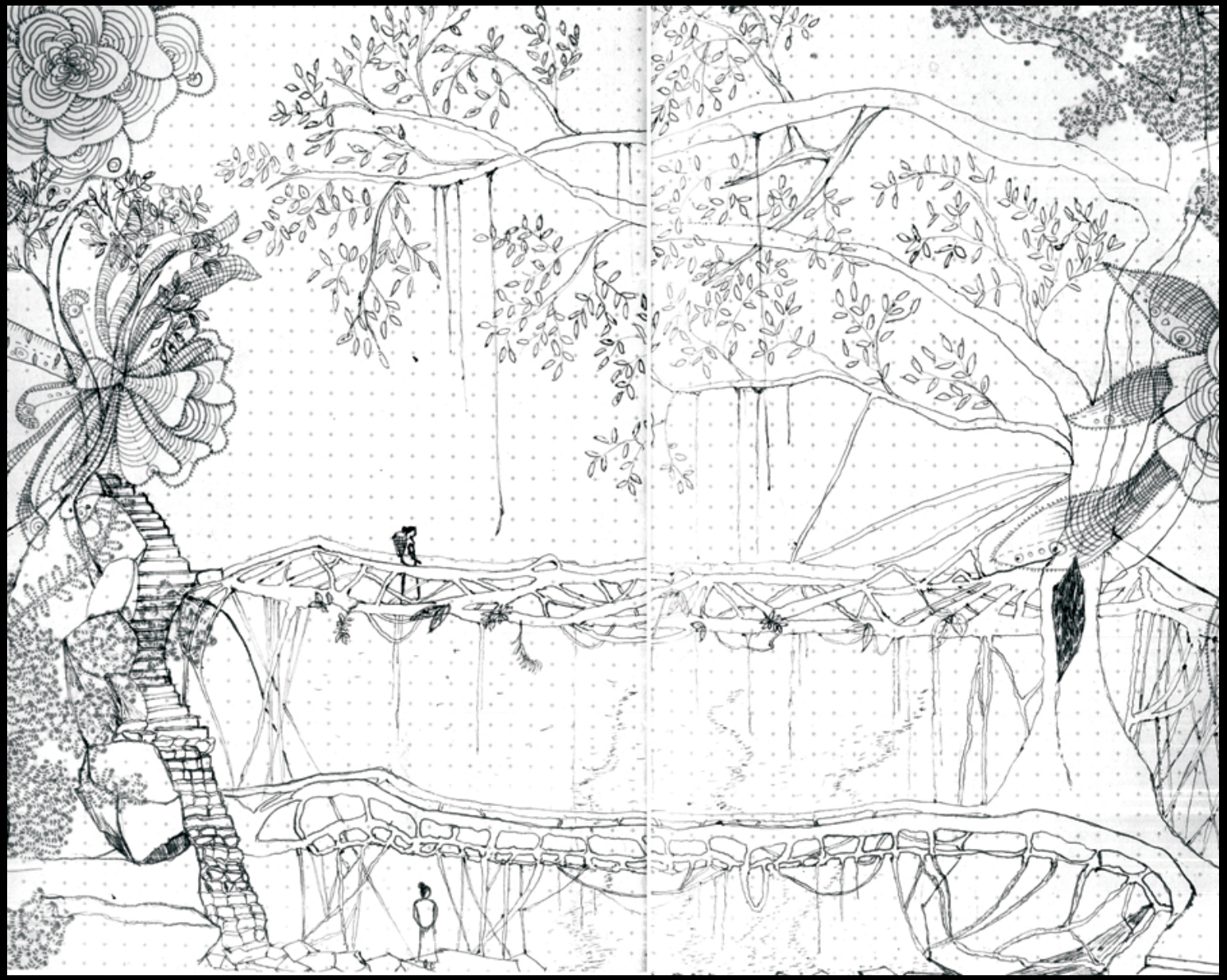

load test
Ficus sapling
Ficus sapling

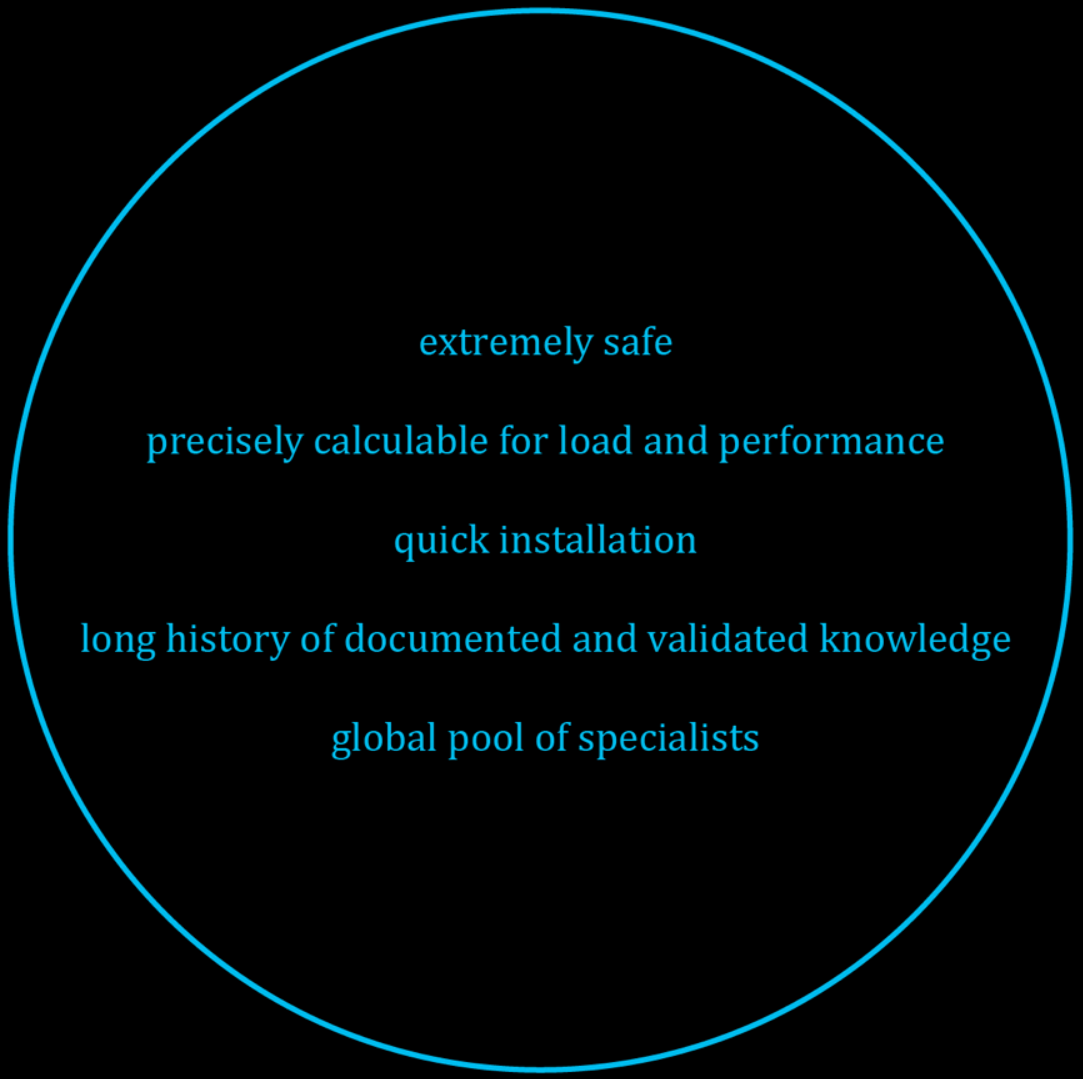

ficus tree
ficus tree
bamboo scaffold
areca catechu root guidance
aerial root inosculation
load test
living root bridge

Village	Span (feet)	Growth stage	Safety level*
Riwai	75	mature	5
Wahryngkoh	15	mid life	3
Mawkyrnot	250	early life	1
Mawkyrnot	150	early life	1
Mawkyrnot	250	mid life	3
Nongthymmai	60	mid life	3
Nongthymmai	80	early life	1
Nongthymmai	20	mature	5
Nongriat	40	mature	5
Nongriat	50	mature	5
Nongriat	60	mid life	3

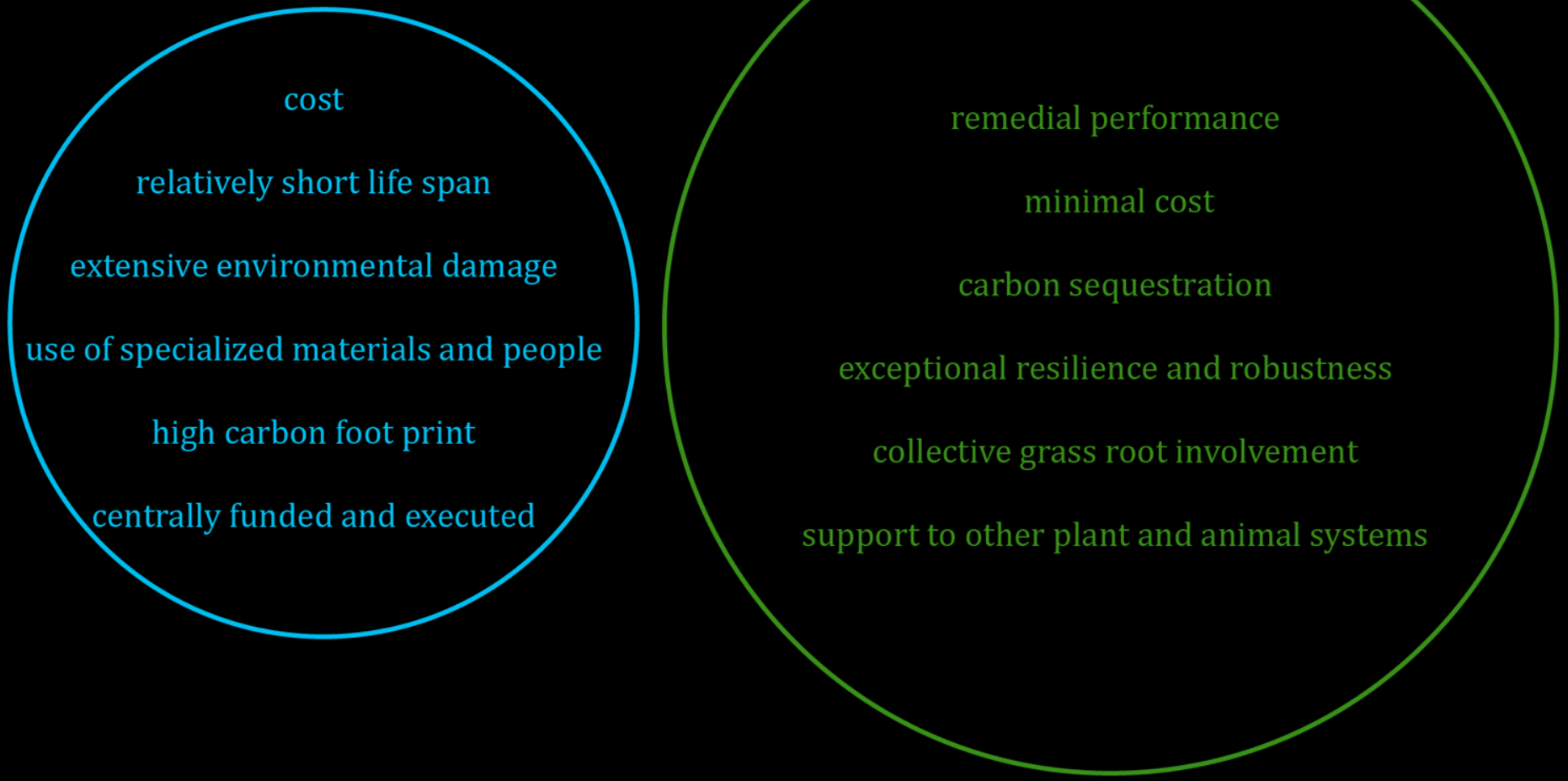
* 5 is safest


1) no environmental damage
2) minimal material and maintenance cost
3) carbon sequestration
4) progressive increase in load bearing capacity
5) remedial properties
6) exceptional longevity and resilience
7) collective grass root involvement
8) support to other plant and animal systems
9) keystone role of *Ficus*



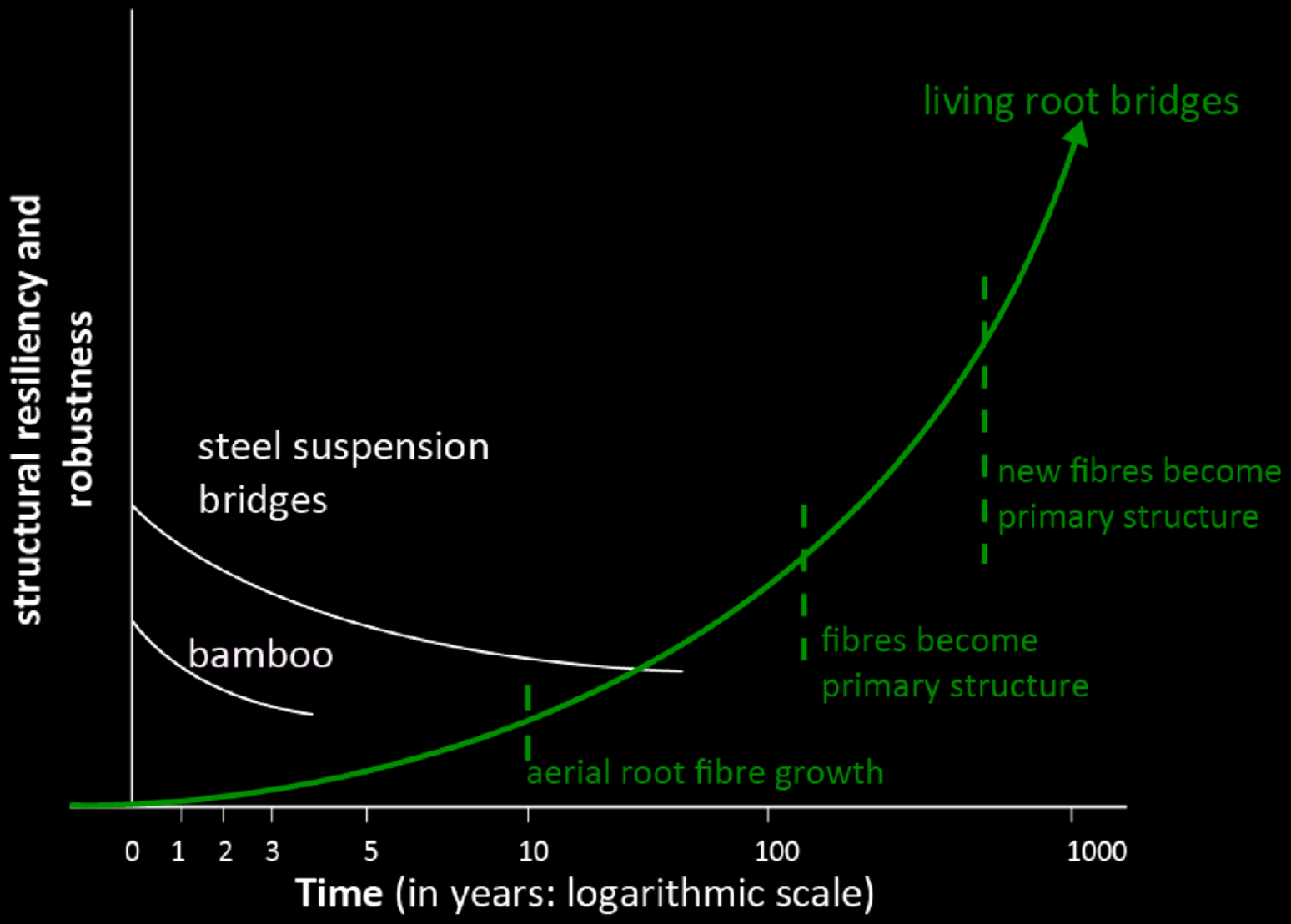

extremely safe
precisely calculable for load and performance
quick installation
long history of documented and validated knowledge
global pool of specialists

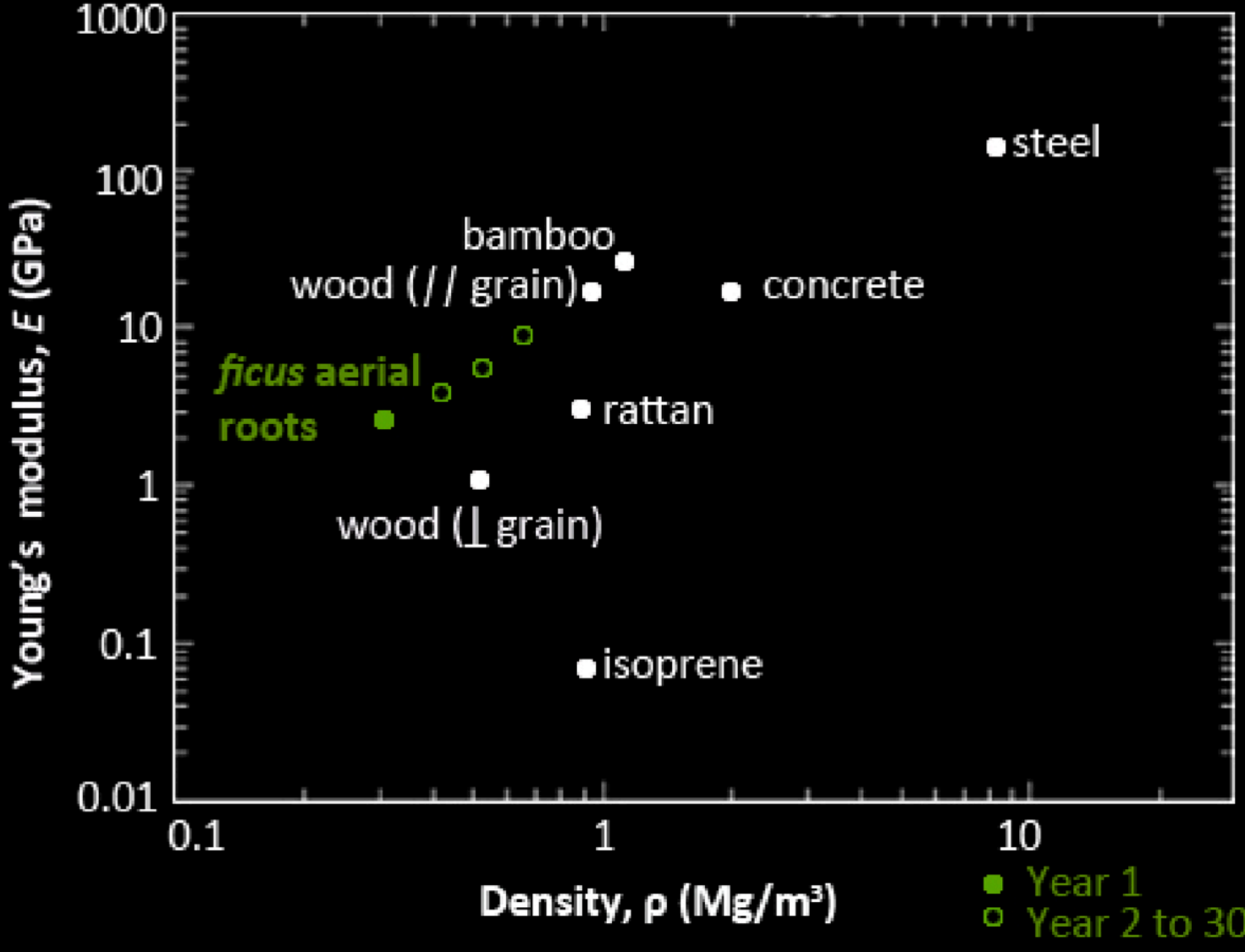

low safety during initial stage
long growth phase
appropriate growth conditions
need for sensitized community


cost
relatively short life span
extensive environmental damage
use of specialized materials and people
high carbon foot print
centrally funded and executed
remedial performance
minimal cost
carbon sequestration
exceptional resilience and robustness
collective grass root involvement
support to other plant and animal systems

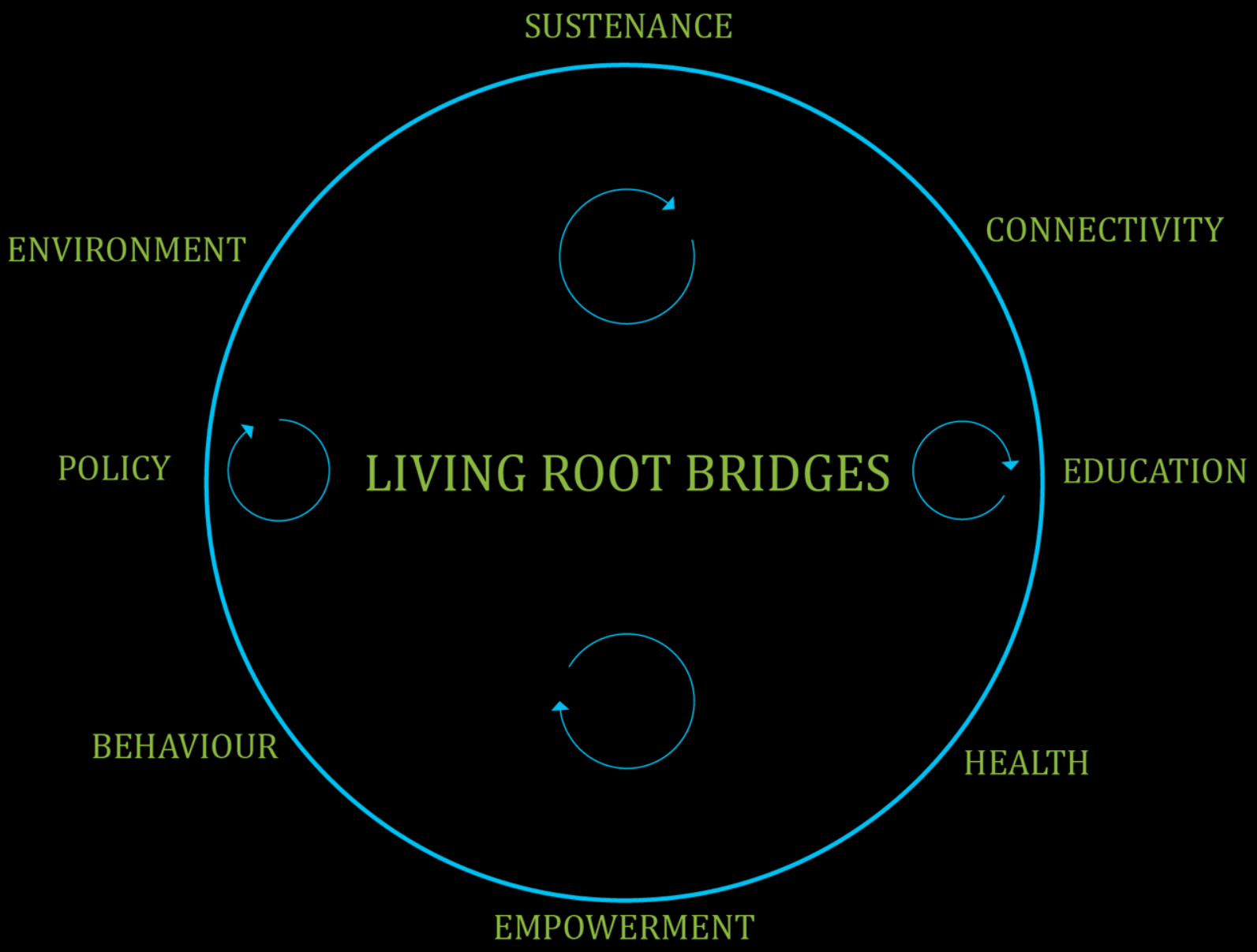

efficiency
optimisation
strength
economy of materials
applied for specific environmental conditions


redundancy
irregularity
complexity
self-organisation
anisotropy
non-linearity


structural resiliency and robustness
living root bridges
steel suspension bridges
bamboo
new fibres become primary structure
fibres become primary structure
aerial root fibre growth
0
1
2
3
5
10
100
1000
Time (in years: logarithmic scale)



(Modified and redrawn) Ashby M., Shercliff H. and Cebon D. Materials Engineering, Science, Processing and Design, Elsevier, Pg 57, 2007


SUSTENANCE
CONNECTIVITY
EDUCATION
HEALTH
EMPOWERMENT
BEHAVIOUR
POLICY
ENVIRONMENT
LIVING ROOT BRIDGES

scientific research and development at different scales

ecology and botany

horticulture

agriculture

social science

structural engineering

architecture, planning

material

systems

resilience

humans

environment

future

ecology | botany

Ficus ecosystem

site, geography

age, growth and physiology

cell and tissue structure through all growth stages

plant-animal interaction

Ficus-Areca catechu-Bamboo

forestry | horticulture | agriculture

ecosystem study

improving the technique

transplanting and propagating

inosculation for non-*Ficus* species

integration with urban and disturbed sites

response to changing climate and geography

designed as a food source

anthropology | ethno-botany | geography

indigenous mind - sacred continuum, time, nature

native plants, tribes and biogeography

traditional knowledge, skills and rituals

food, medicine, habitat, land ownership

philosophy and worldview

design | architecture | planning

living plant-based solutions in architecture, landscape, urban design and planning

novel structural systems for extreme climates

technologies for forest regeneration

community-based grass root horticultural solutions

human-plant interaction

civil | structural engineering

mapping and measurement

structural analysis

performance under extreme climate and external stresses

change in performance with time and growth

redesign of scaffold and root guidance system

plant stress, performance, resilience

future

conservation, scientific study and analysis, application

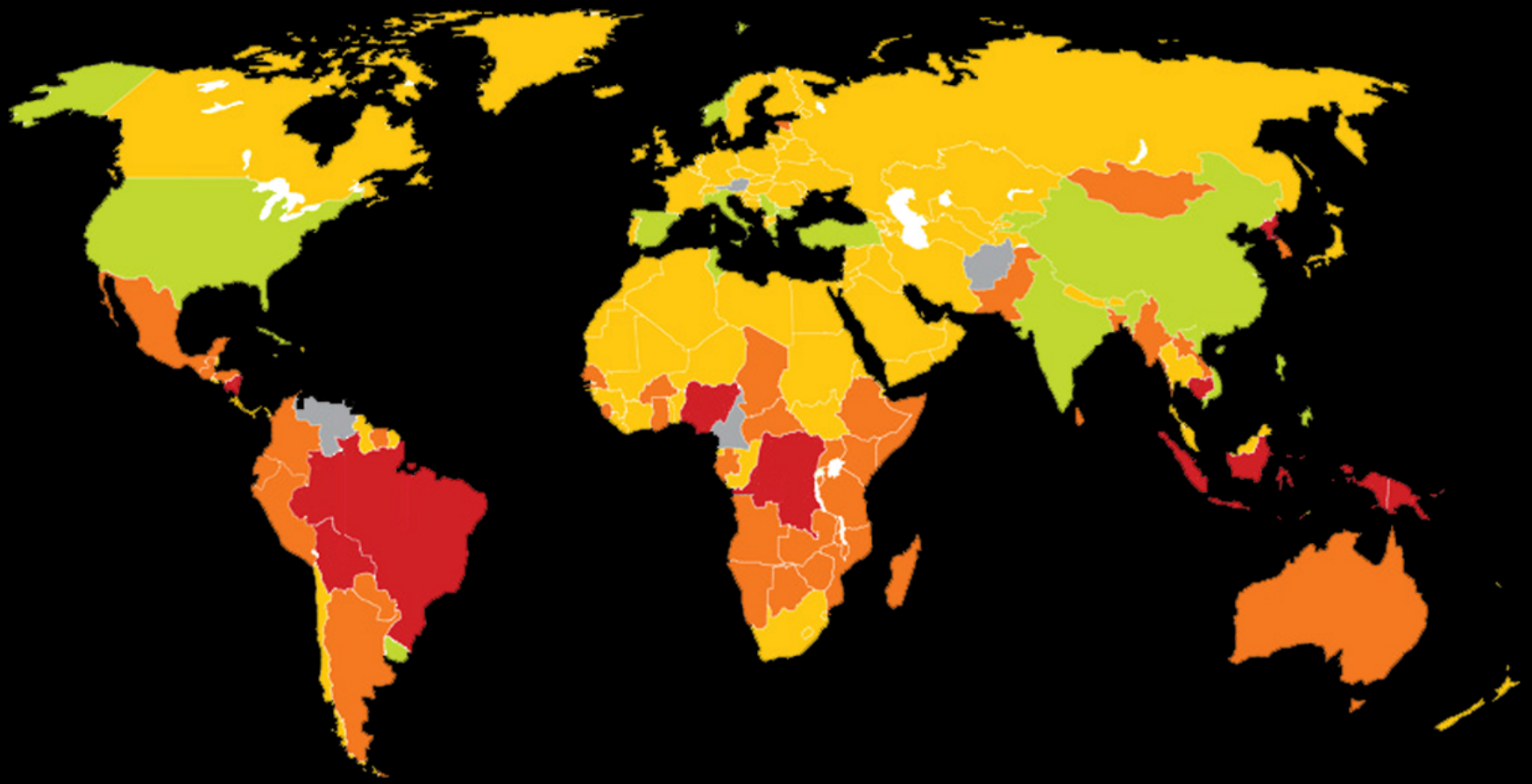
human impact - climate change and socio-ecological resilience

science - *Ficus* ecology, biogeography, rural connectivity, tropical ecologogy

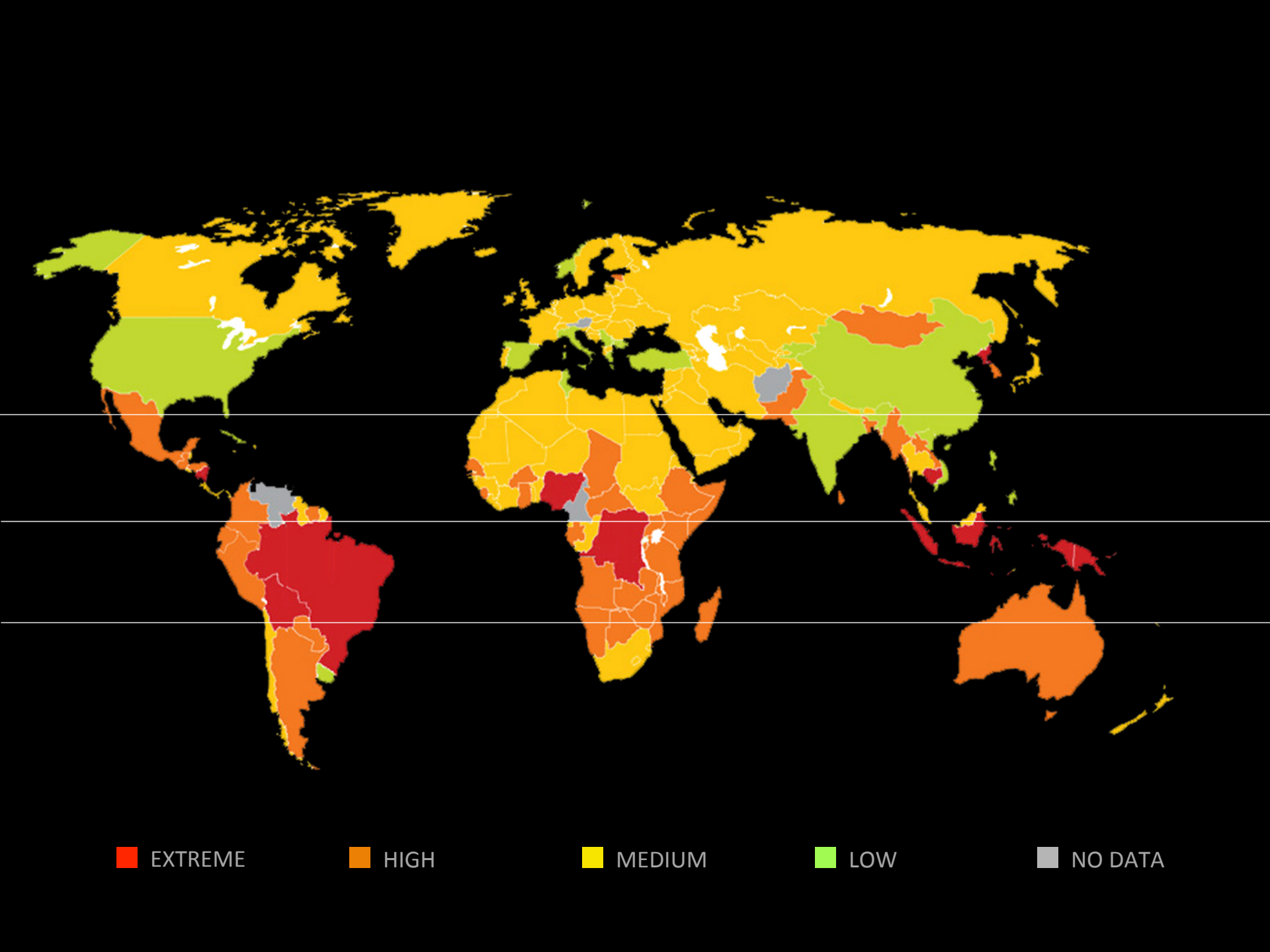
application - sustainable forestry and agriculture, reforestation

GLOBAL FOREST LOSS MAP

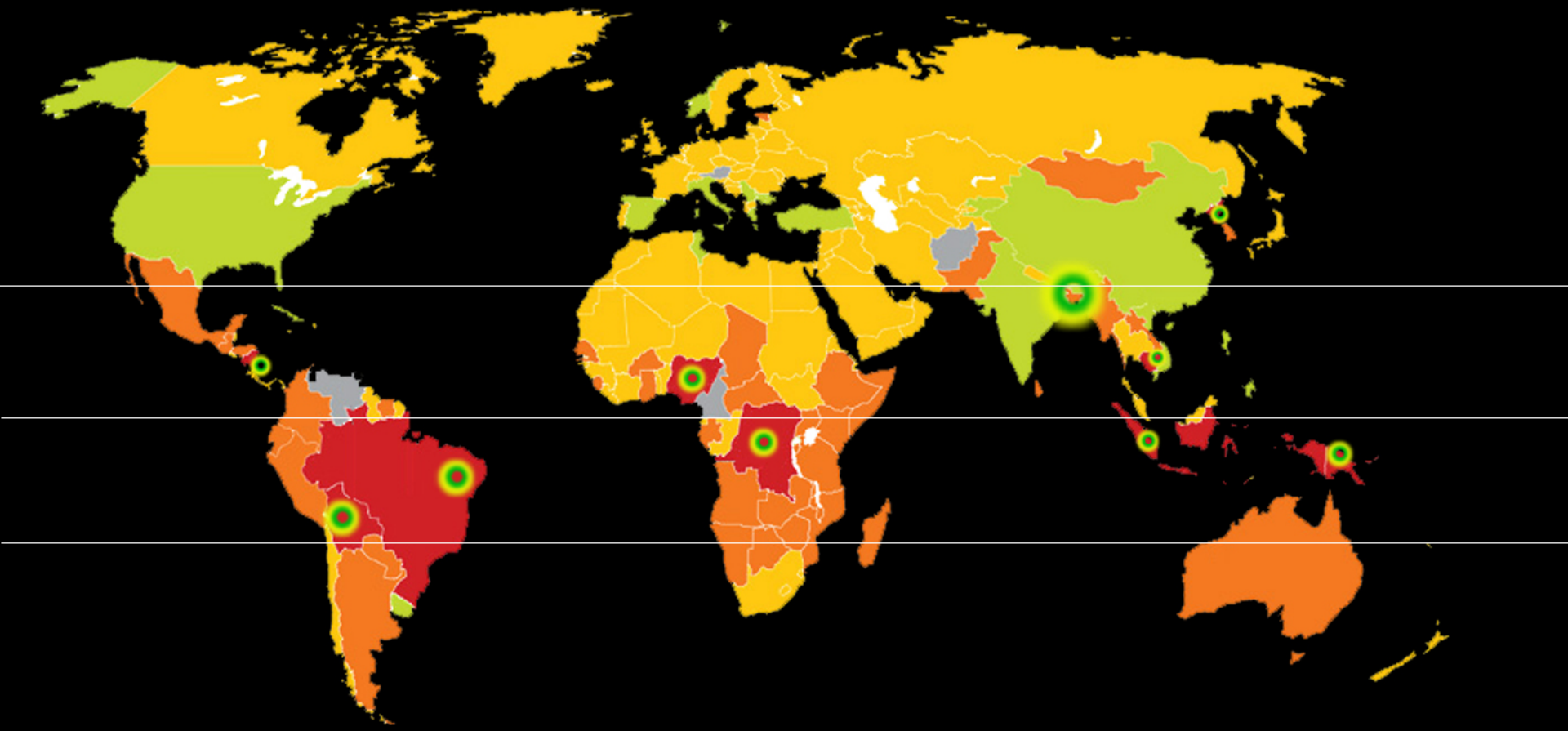
WWW.GLOBALFORESTWATCH.ORG



EXTREME HIGH MEDIUM LOW NO DATA


EXTREME
HIGH
MEDIUM
LOW
NO DATA

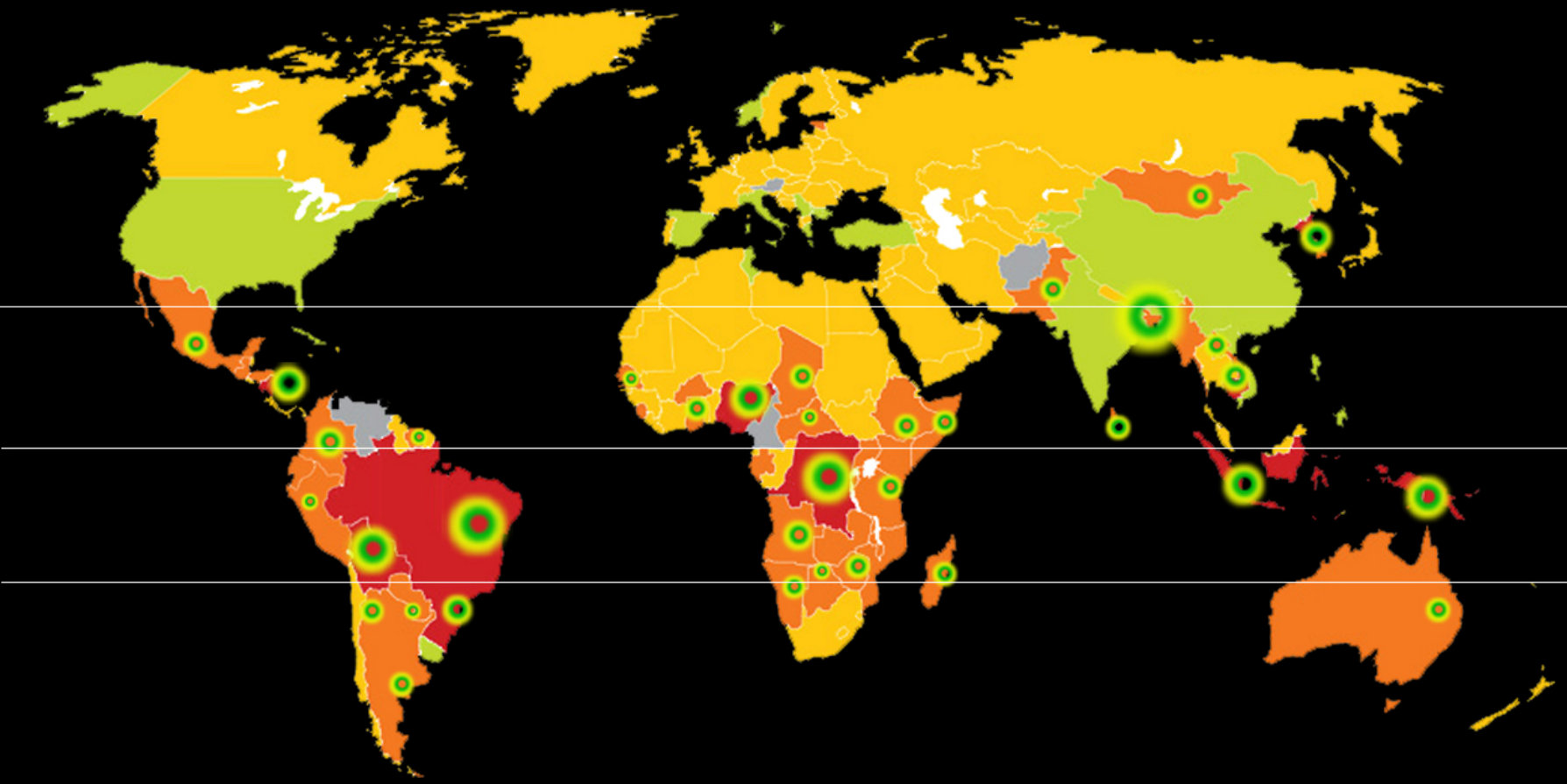
FICUS-BASED FOREST REGENERATION



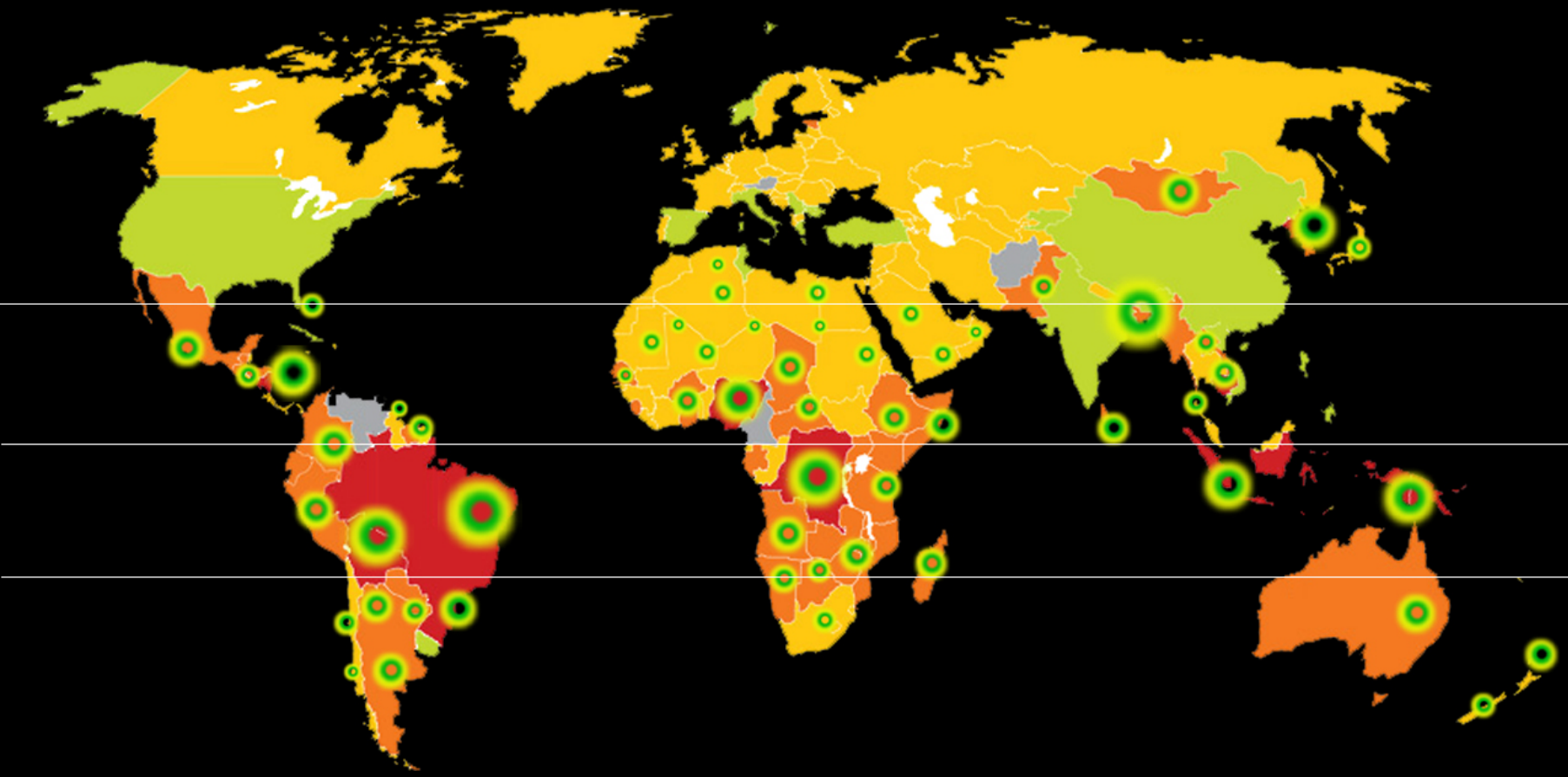
SCIENTIFIC REFERENCE

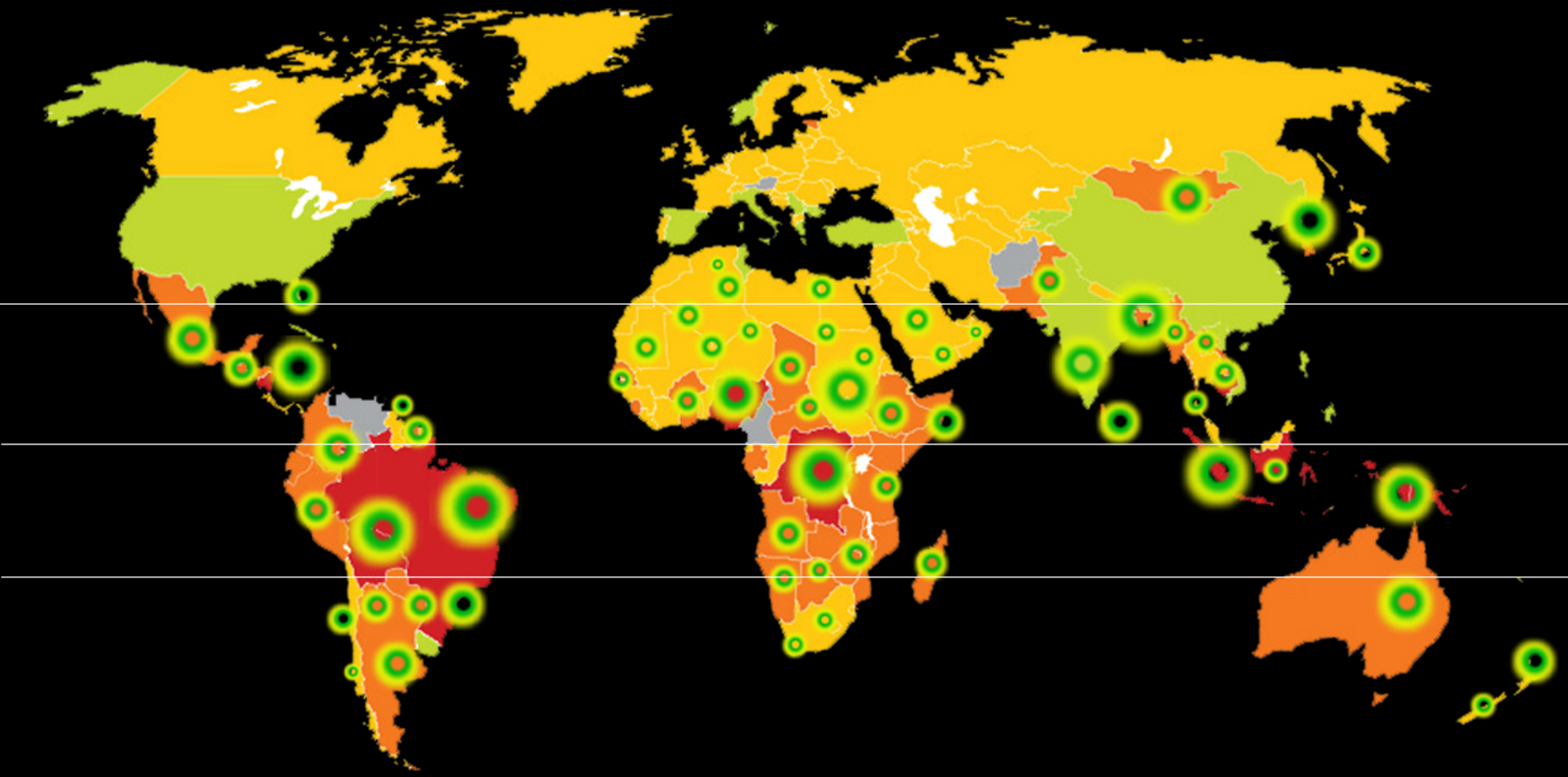
Guevara S., Laborde J. and Rios S. G. *Rain Forest Regeneration beneath the Canopy of Fig Trees Isolated in Pastures of Los Tuxtlas, Mexico*, Biotropica, Vol. 36, No. 1 (Mar., 2004), pp. 99-108.

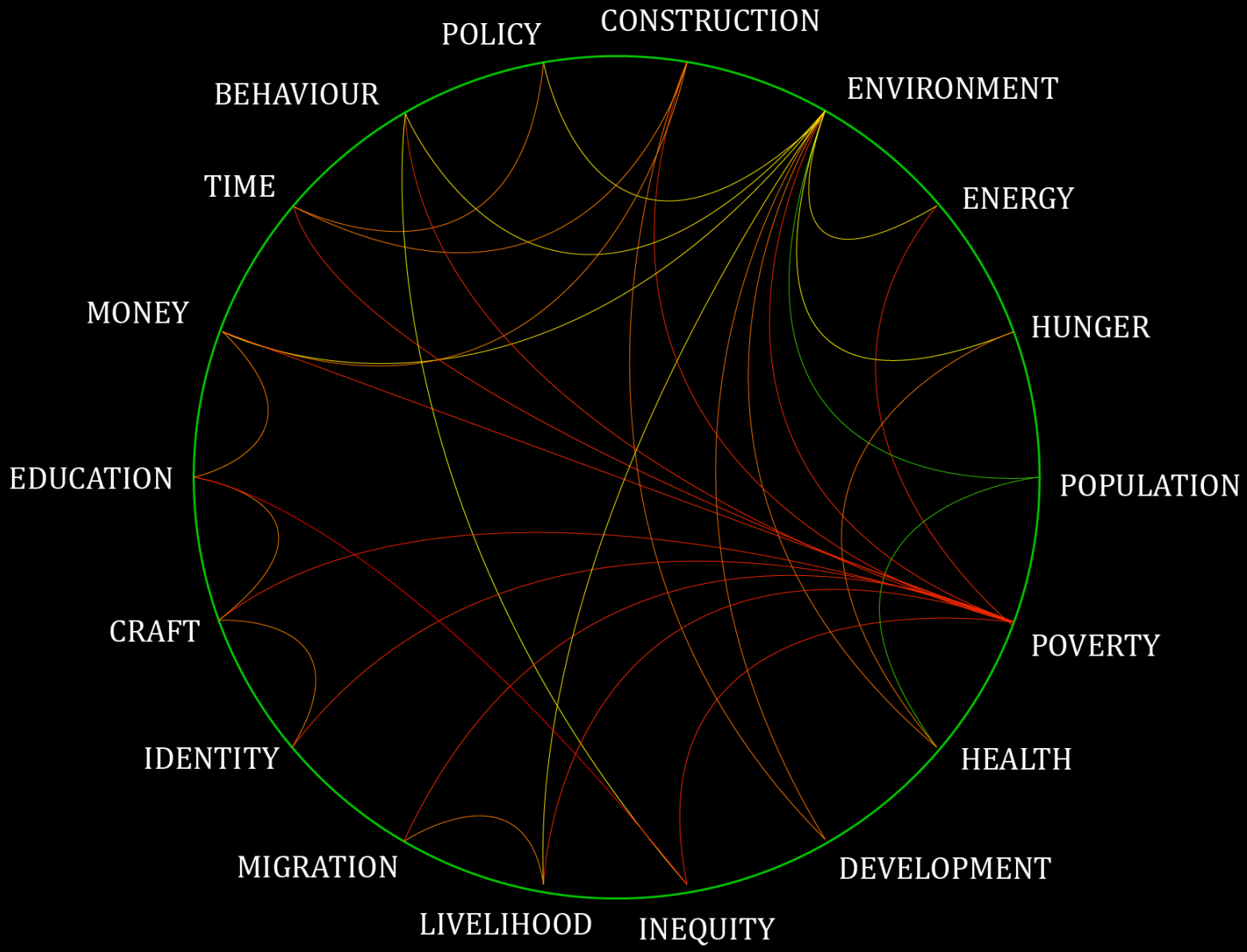
FICUS-BASED SOCIO-ECONOMIC-ECOLOGICAL RESILIENCE



FICUS-BASED SOCIO-ECONOMIC-ECOLOGICAL RESILIENCE



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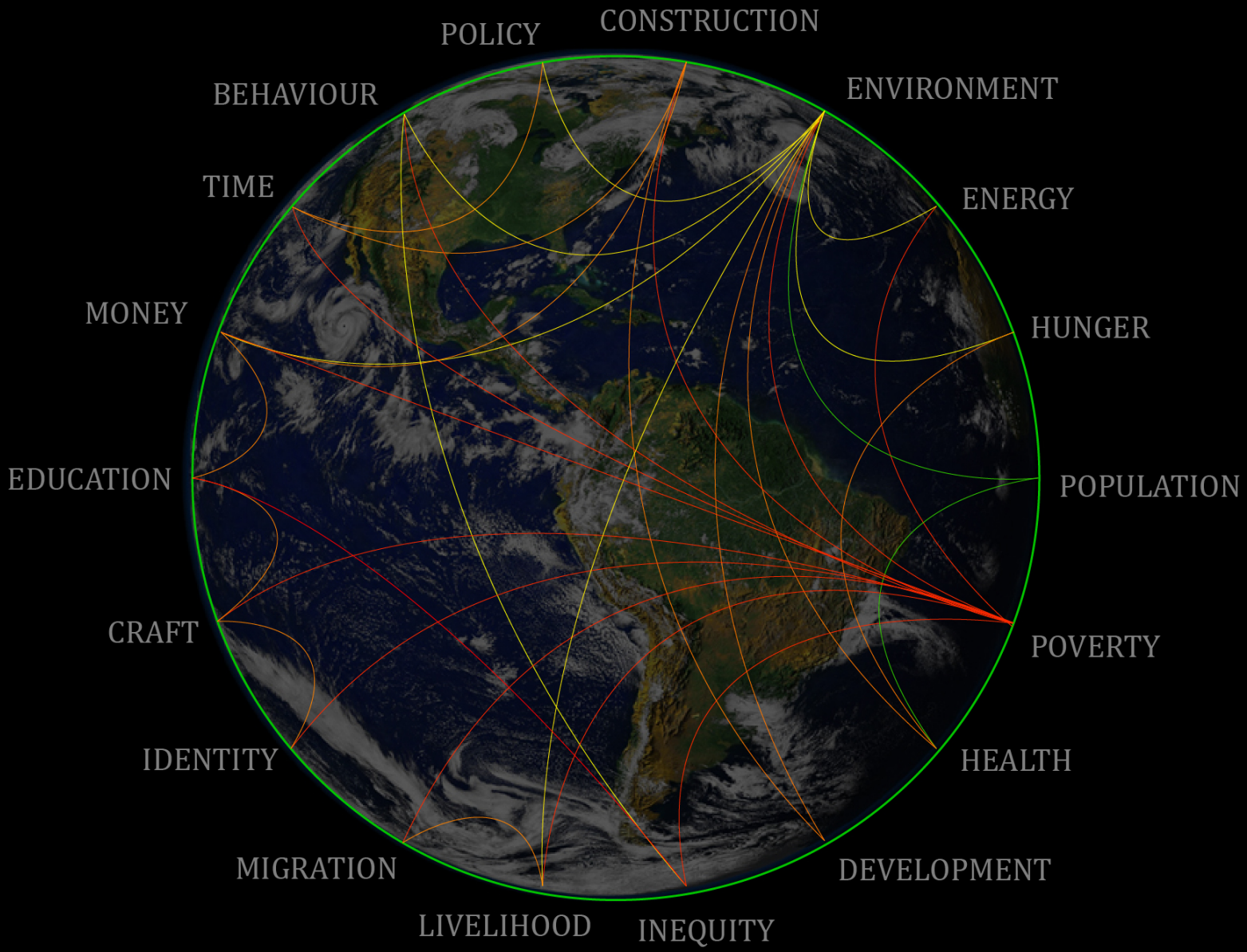
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