Bringing Scale and Trust to Carbon Credits Through Computer Science

S. Keshav

University of Cambridge
June 2022

This work was done in collaboration with A. Balmford (Zoology), D. Coomes (Plant Sc.), A. Madhavapeddy (CS), and T. Swinfield (Zoology); all at Cambridge

The 21st century faces two crises

Climate

The 21st century faces two crises

Climate

Biodiversity

Nature-based solutions address both

Forest conservation

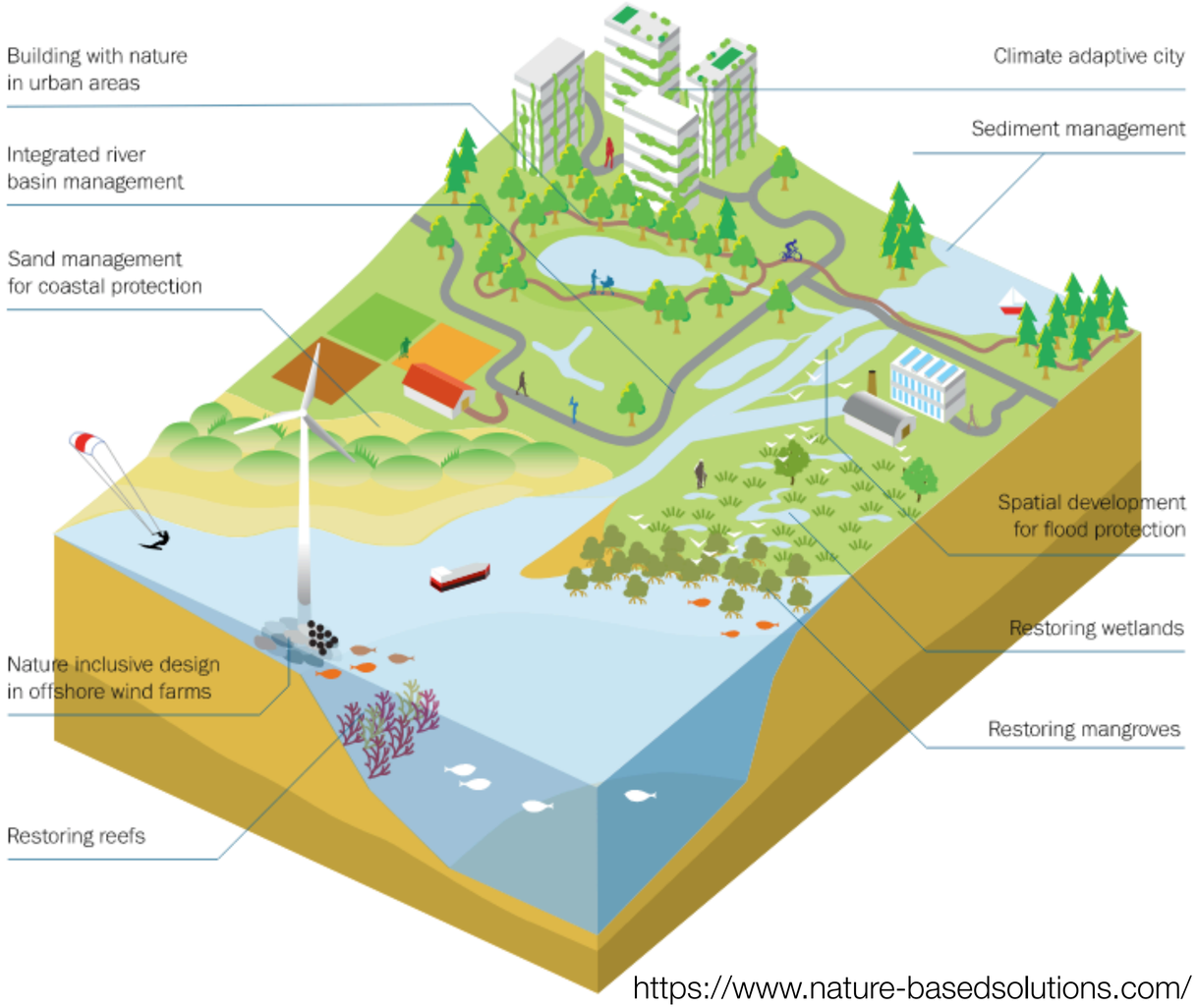
Re-forestation in woodlands and forests

Peatlands renewal

Seagrass and mangrove plantations

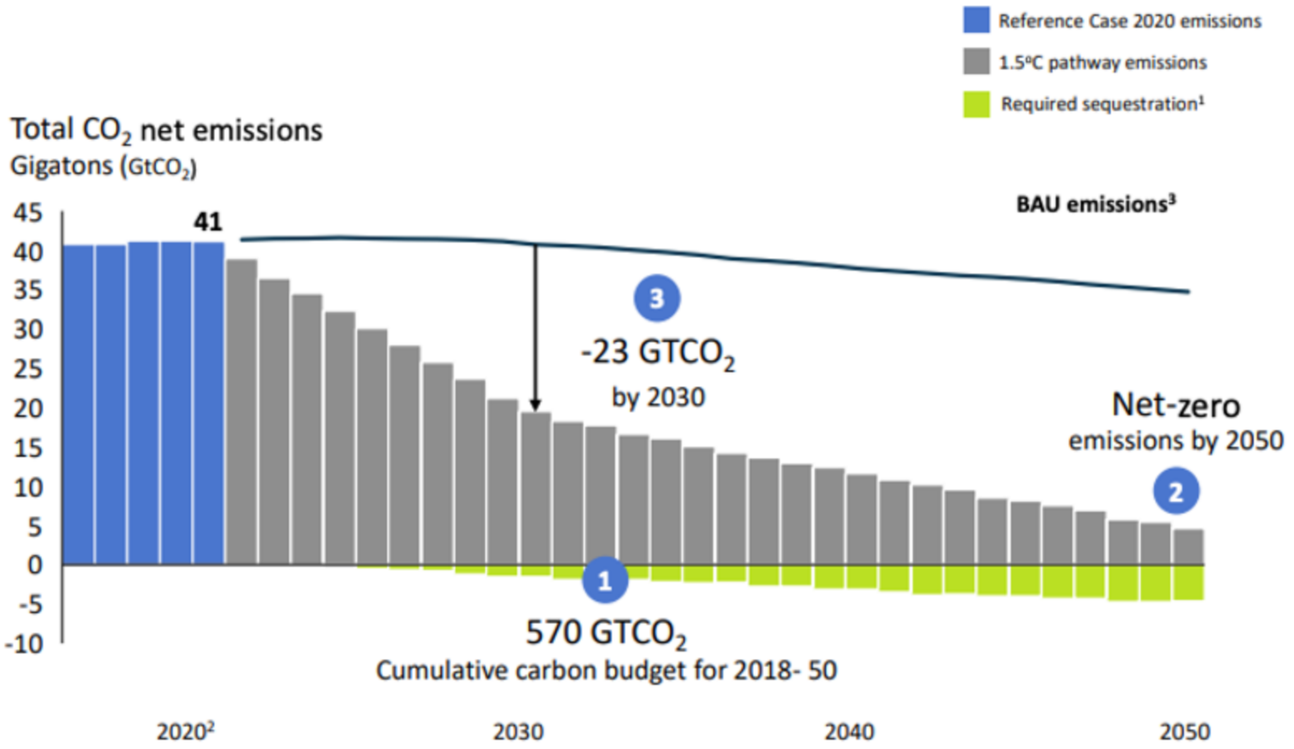
Re-wilding agricultural land

…



https://www.nature-basedsolutions.com/

Every path to net zero needs carbon sequestration



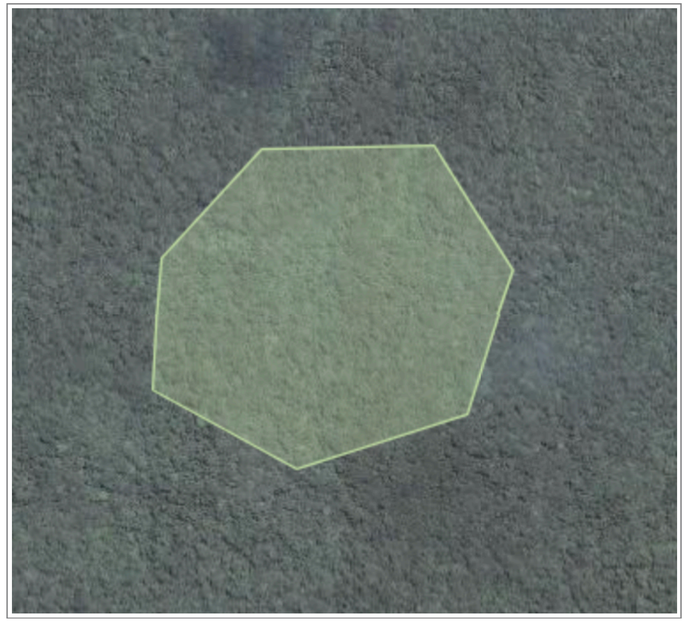
https://www.cambridgefinsights.com/post/net-zero-by-2050-scaling-up-the-voluntary-carbon-markets

Funding NbS via carbon credits today

Gold Standard®

VERRA

- Standards
- Auditing



Project

- Additionality
- Leakage
- Permanence
- Co-benefits

Credits

Old schemes and scams are lurking under the shadow of the “nature-based solutions” umbrella

By Coraina de la Plaza, GFC, Spain

https://globalforestcoalition.org/forest-cover-61/#fc6102

Our Nature is Not Your Solution – and FAO’s Plantations are even less of a Solution!

https://globalforestcoalition.org/faos-plantations/

Subscribe | Latest Issues | SCIENTIFIC AMERICAN | Cart 0 | Sign In | Newsletters

CORONAVIRUS | THE SCIENCES | MIND | HEALTH | TECH | SUSTAINABILITY | VIDEO | PODCASTS | OPINION | PUBLICATIONS

Read Our Latest Issue | Read Now

SUSTAINABILITY

Greenhouse Gas Emission Offsets May Be Fraudulent

Offsets for the emissions that cause climate change from around the globe may have been faked

Bloomberg Green | Sign In | Subscribe

Photographer: Chris Ratcliffe/Bloomberg

QuickTake

Why ‘Carbon Offsets’ Don’t Do All That They Promise

By Akshat Rathi and Ryan Williams
15 August 2020, 05:00 BST

Old schemes and scams are lurking under the shadow of the “nature-based solutions” umbrella

By Coraina de la Plaza, GFC, Spain

https://globalforestcoalition.org/forest-cover-61/#fc6102

Our Nature is Not Your Solution – and FAO’s Plantations are even less of a Solution!

Subscribe | Latest Issues | SCIENTIFIC AMERICAN | Cart 0 | Sign In | Newsletters

CORONAVIRUS | THE SCIENCES | MIND | HEALTH | TECH | SUSTAINABILITY | VIDEO | PODCASTS | OPINION | PUBLICATIONS

Read Our Latest Issue | Read Now

SUSTAINABILITY

Greenhouse Gas Emission Offsets May Be Fraudulent

Offsets for the emissions that cause climate change from around the globe may have been faked

https://globalforestcoalition.org/faos-plantations/

Bloomberg Green | Sign In | Subscribe

Photographer: Chris Ratcliffe/Bloomberg

QuickTake

Why ‘Carbon Offsets’ Don’t Do All That They Promise

By Akshat Rathi and Ryan Williams
15 August 2020, 05:00 BST

Difficult to quantify

Difficult to verify

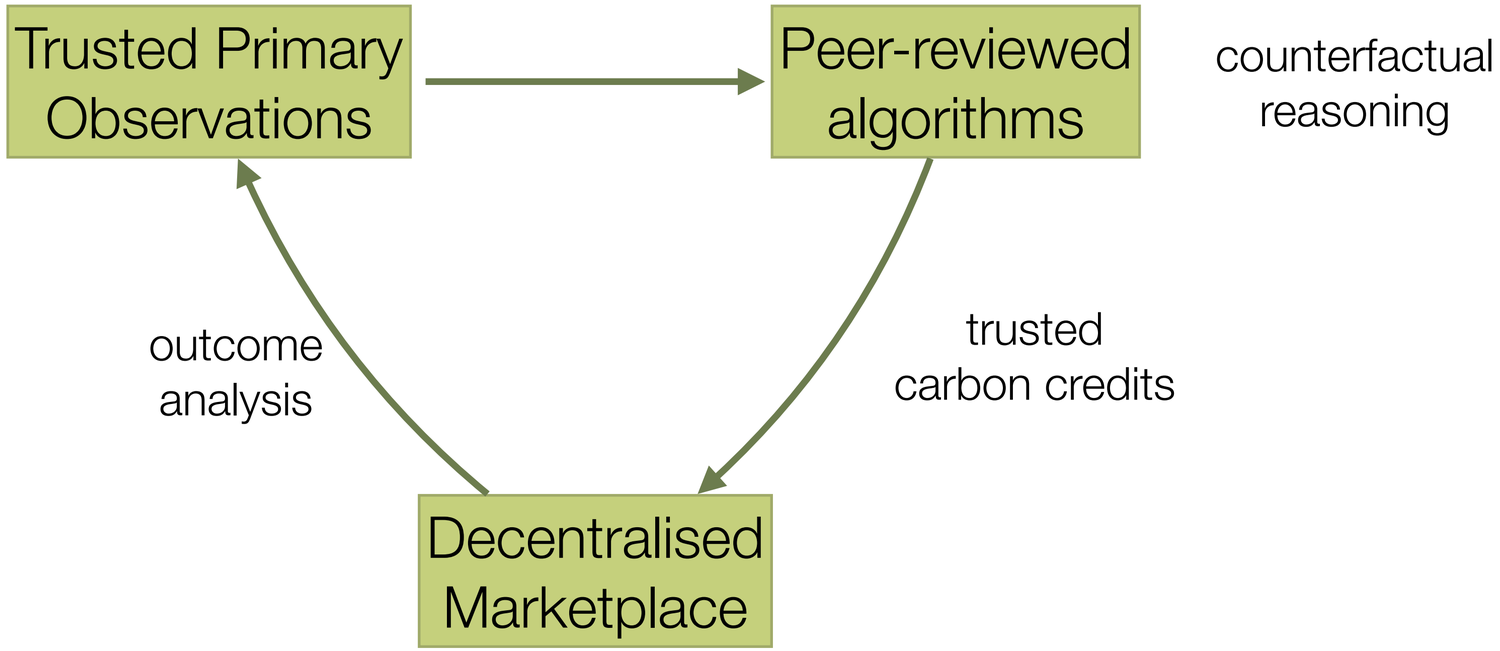
Difficult to scale

Trusted, scaleable carbon credits can **unlock** ESG funds

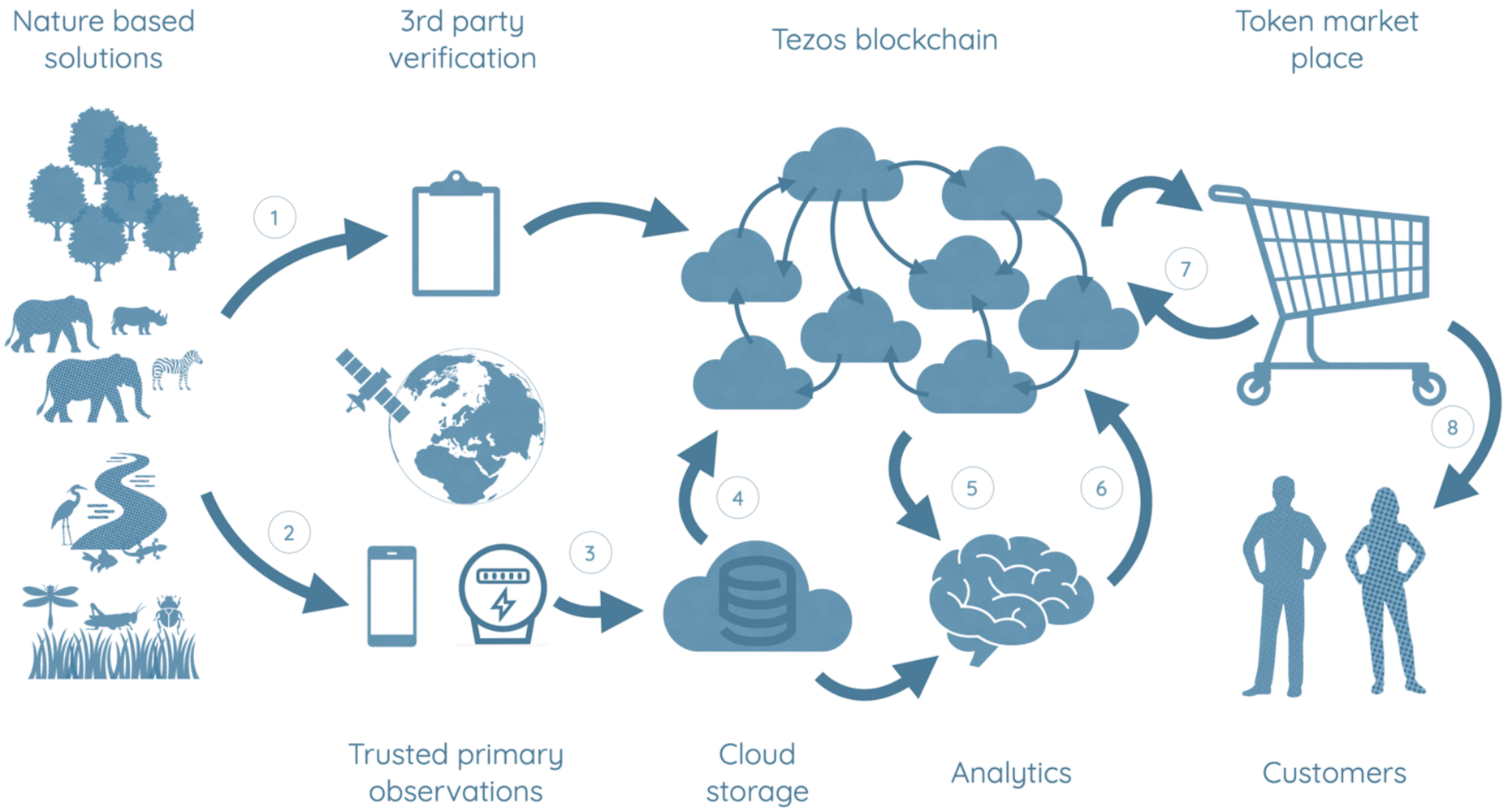
"Total assets in sustainable funds hit a record of almost $1.7tn, up 50 per cent over the year, on the back of a record year for sustainable fund sales."

— Financial Times, Feb 6, 2021

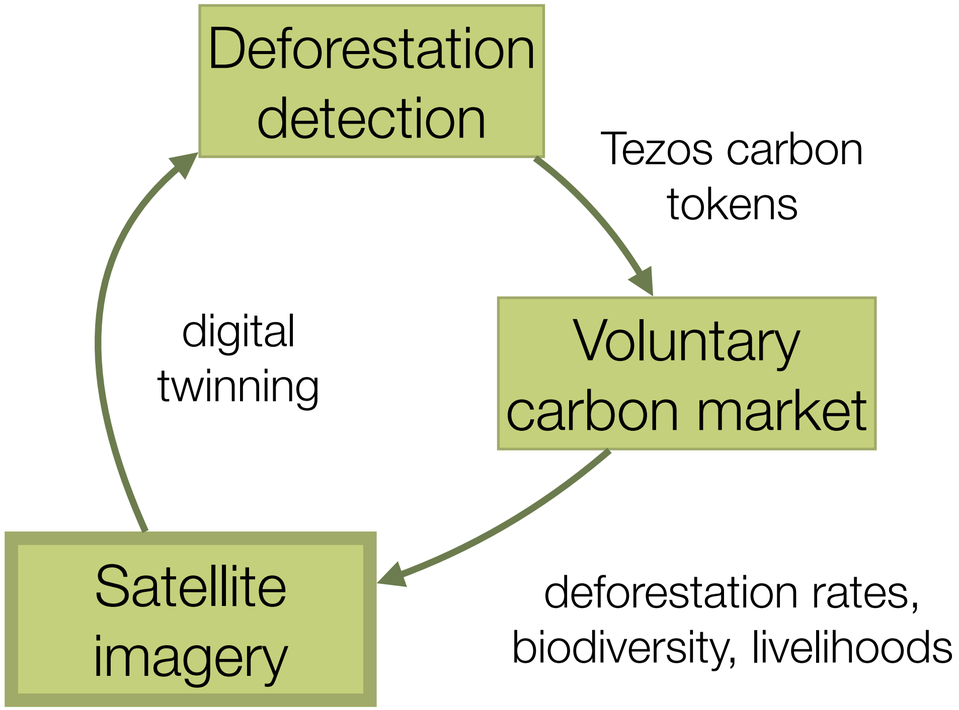
Our framework



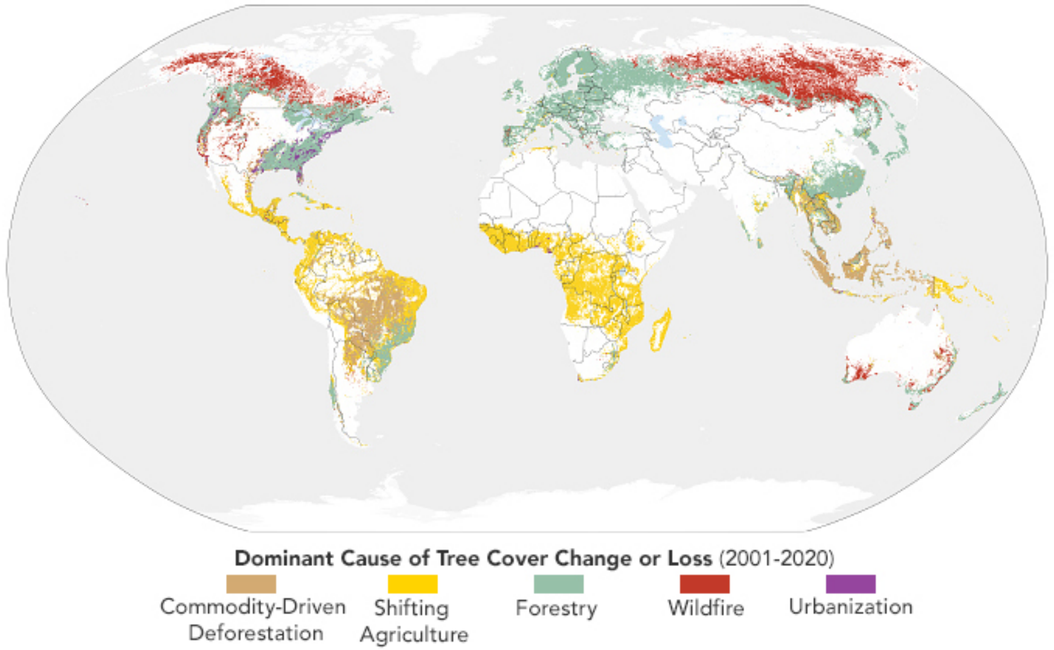
Underlying system



Example: credits for averting deforestation

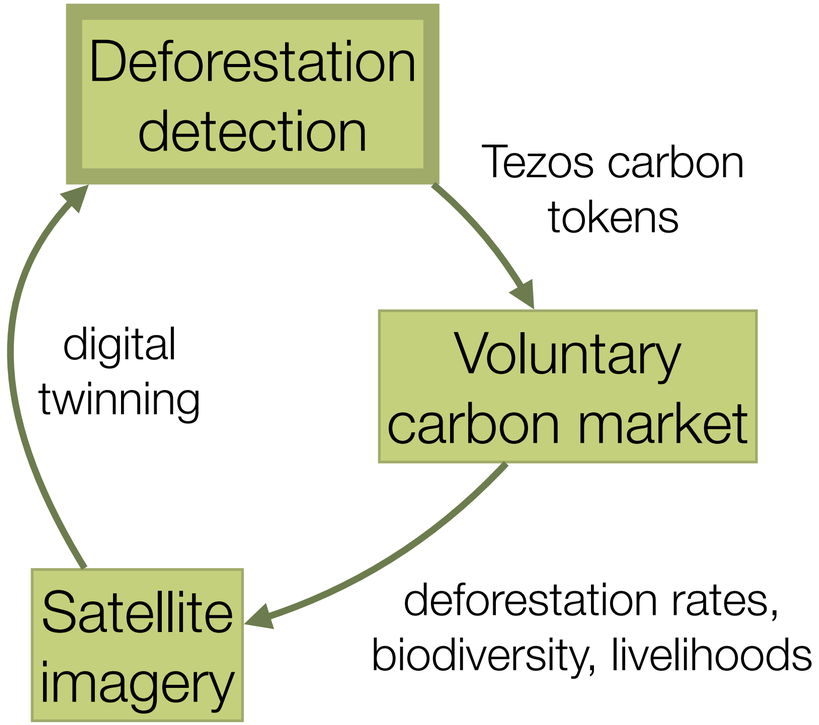


Detect deforestation from satellite imagery (GEDI-4, Landsat, MODIS)



https://landsat.visibleearth.nasa.gov/view.php?id=148674

Analytics



Counterfactual algorithms to measure

- additionality
- leakage
- impermanence

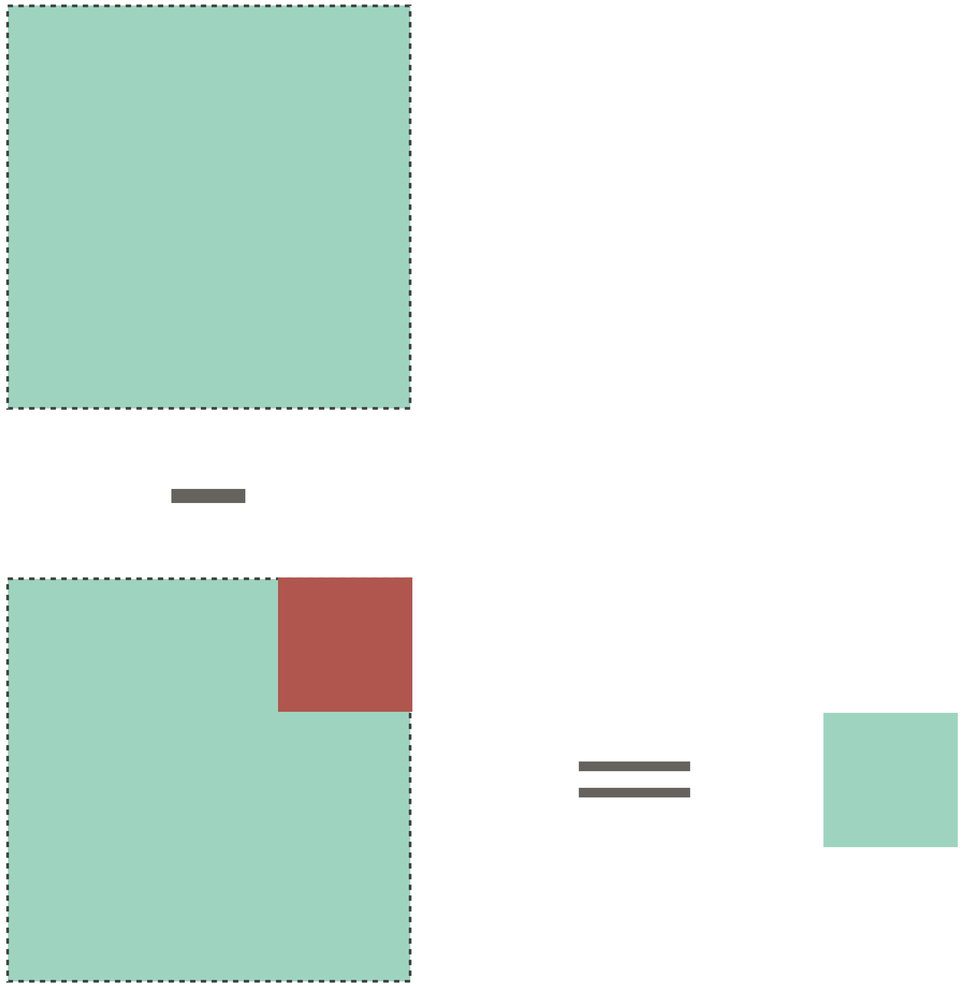
and estimate co-benefits

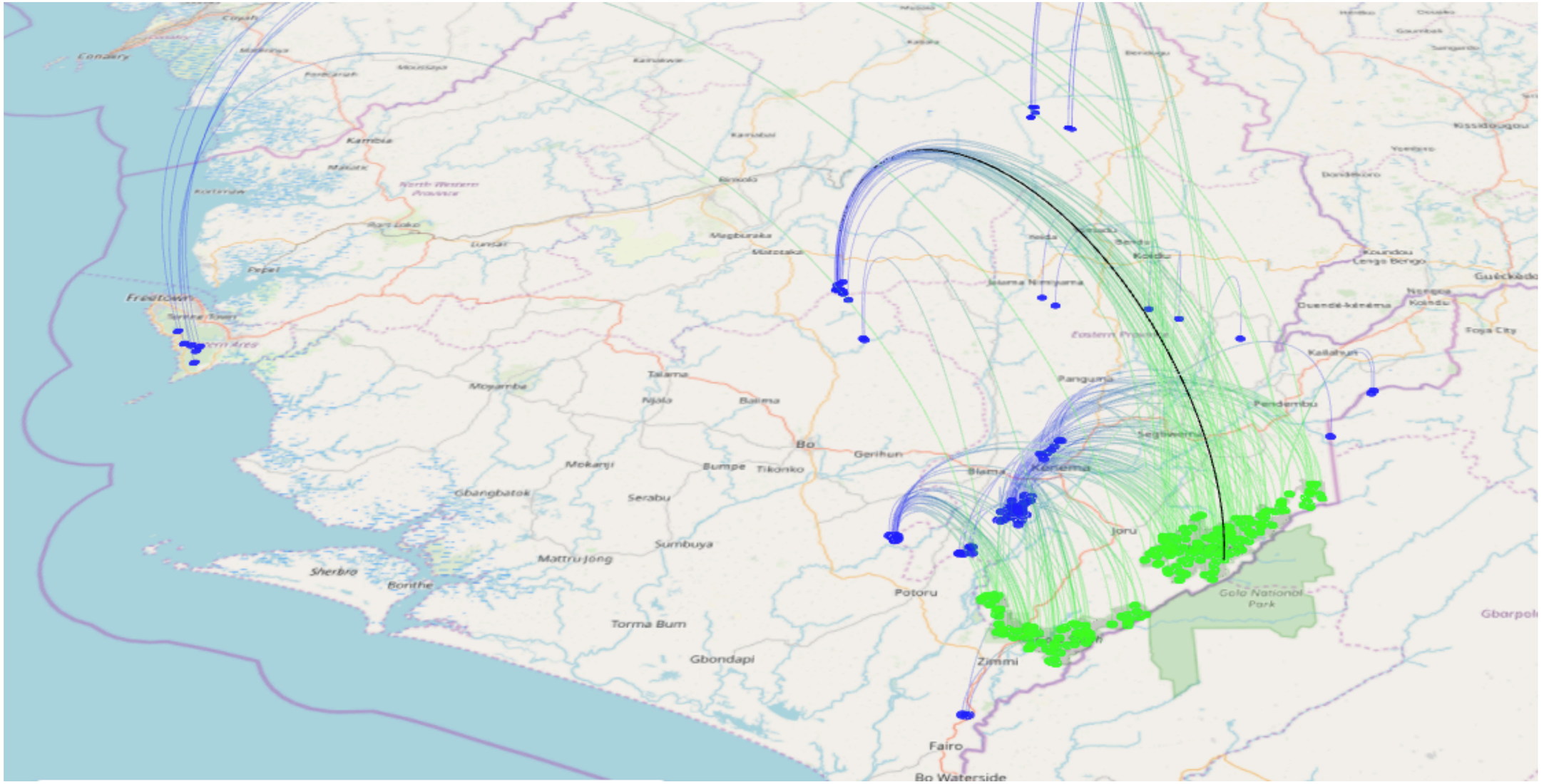
- biodiversity
- justice
- local livelihoods

Additionality

Treatment

Counterfactual

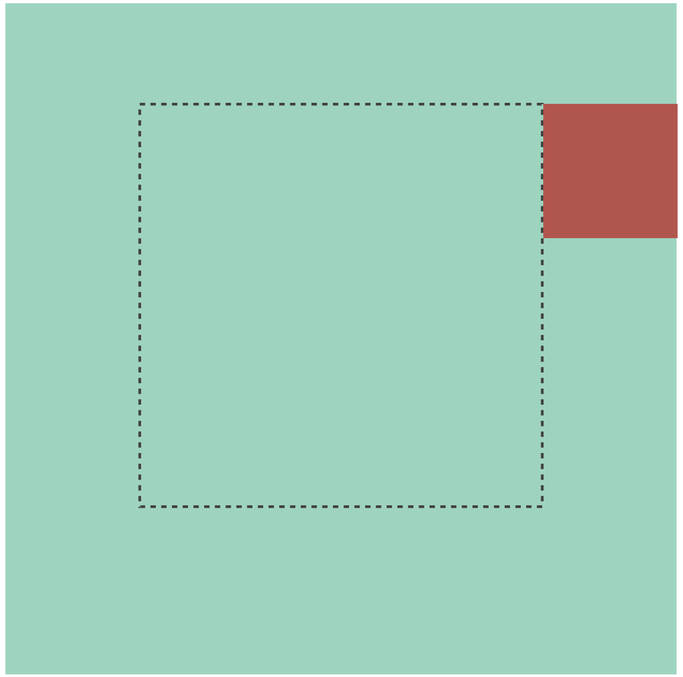




AI can help find the best matches

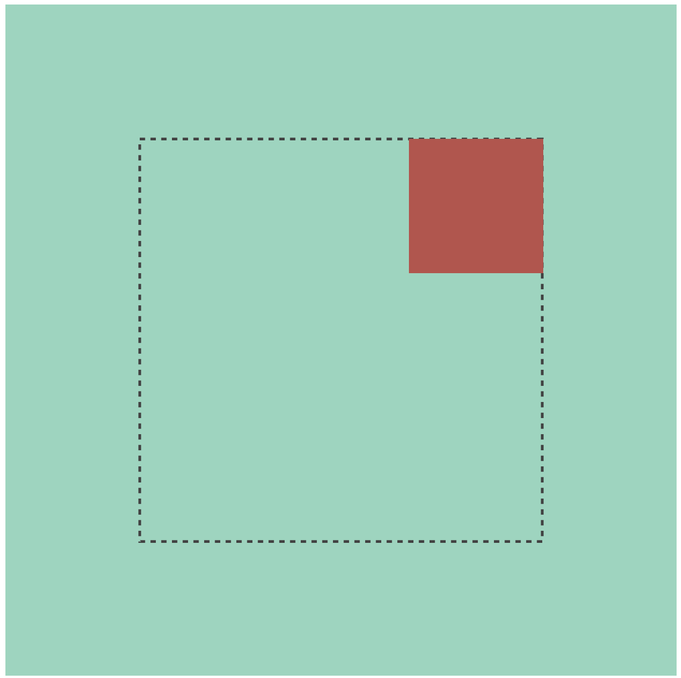
Local leakage

Treatment



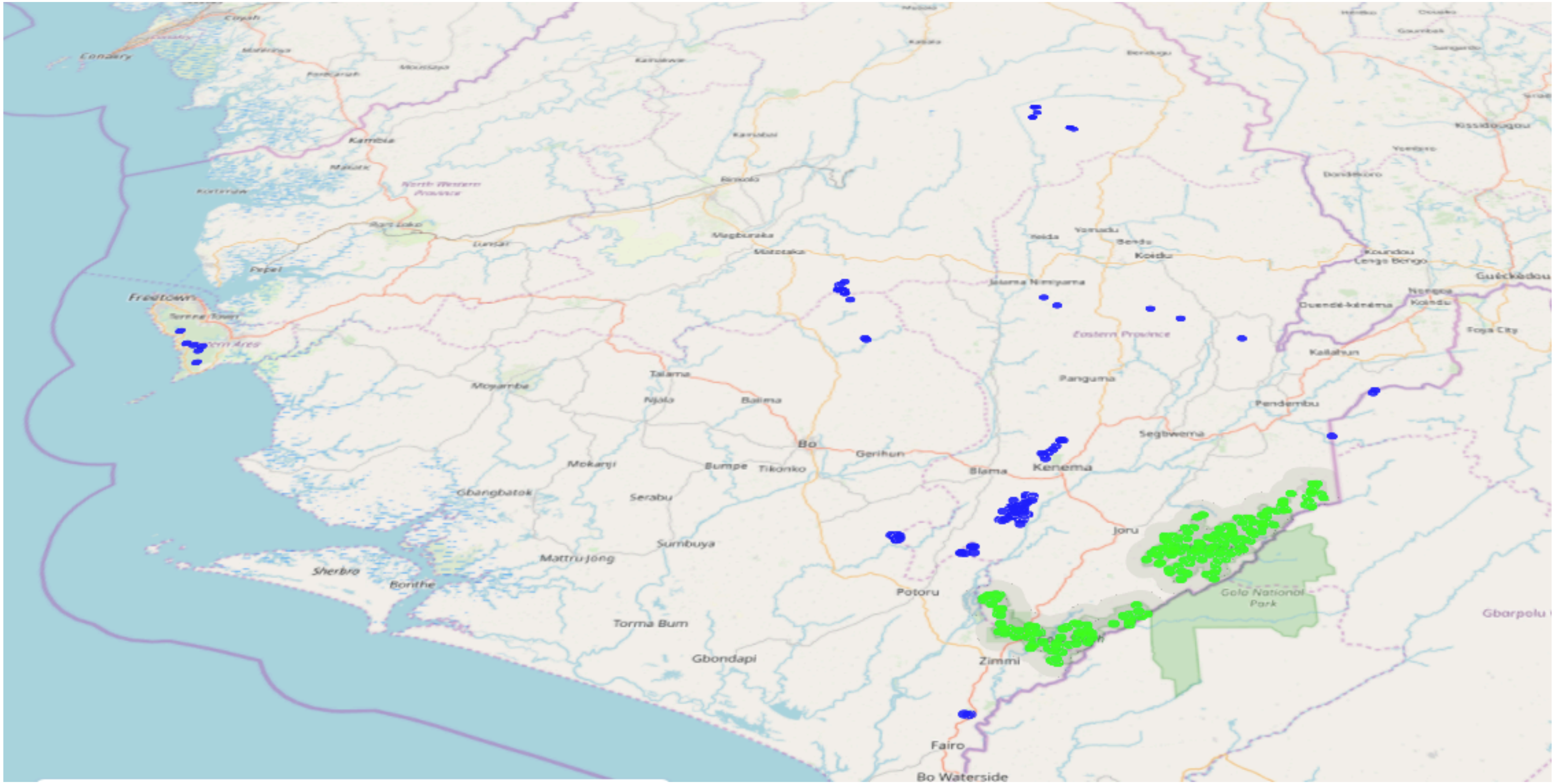
–

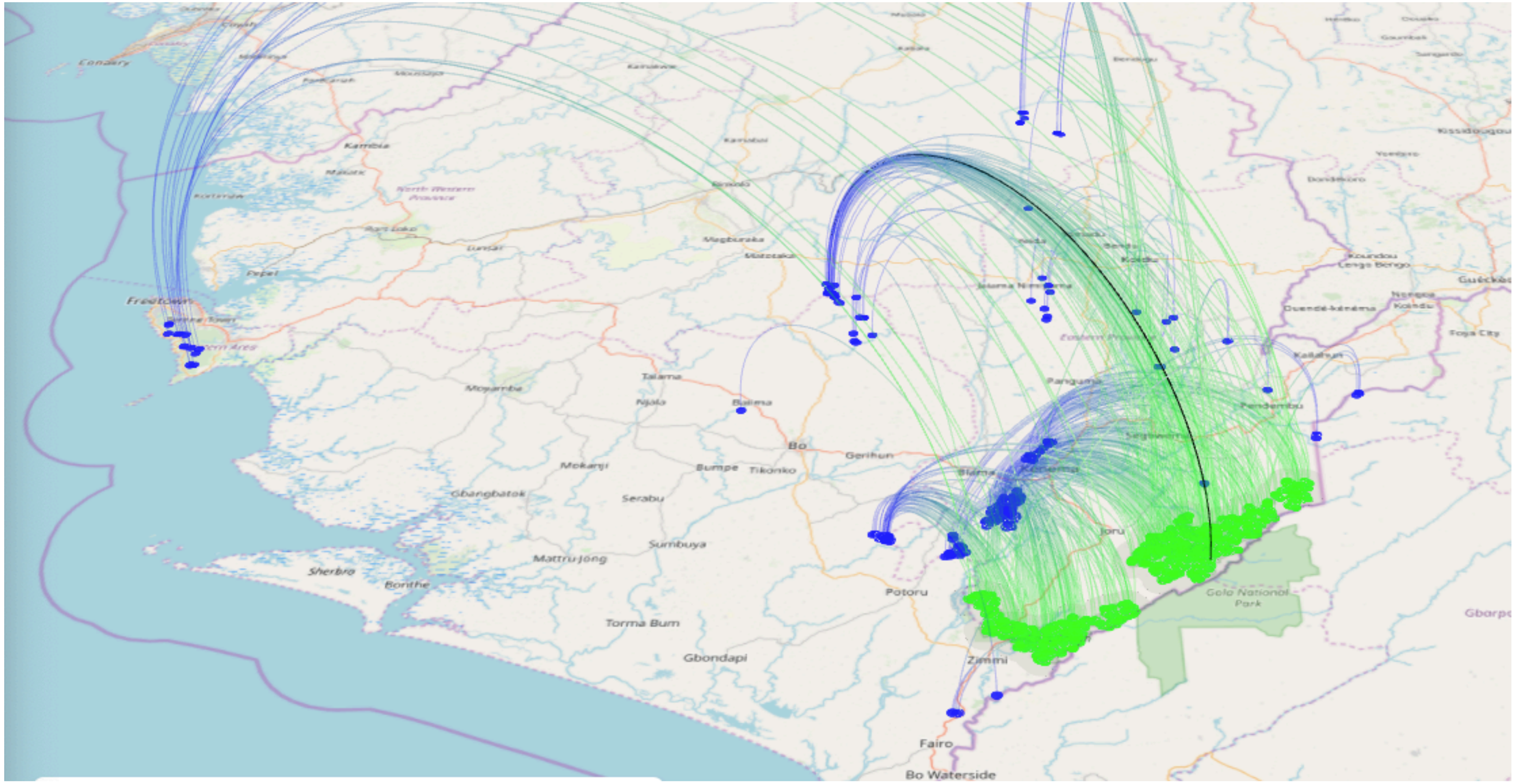
Counterfactual



The net gain in **atmospheric** $CO2_e$ as a direct consequence of an intervention

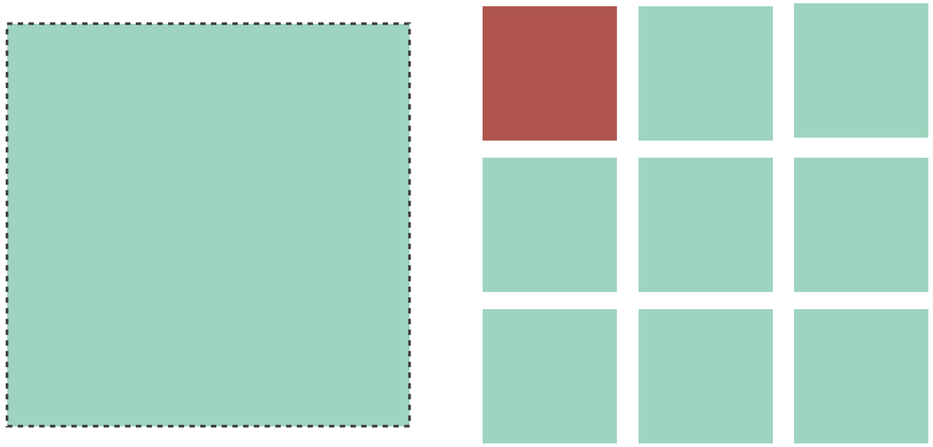
= X


Freetown
Kambia
Magburaka
Koidu
Eastern Province
Kailahun
Panguma
Pendembu
Segbwema
Bo
Gerihun
Blama
Kenema
Joru
Moyamba
Taiama
Njala
Mokanji
Bumpe
Tikonko
Gbangbatok
Serabu
Sumbuya
Mattru Jong
Sherbro
Bonthe
Torma Bum
Gbondapi
Potoru
Zimmi
Fairo
Bo Waterside
Gola National Park
Gbarpolu
Guéckédou
Foya City


Conakry
Kambia
Port Loko
Pepel
Freetown
Moyamba
Bo
Bumpe
Mokanji
Gbangbatok
Serabu
Sumbuya
Mattru Jong
Sherbro
Bonthe
Torma Bum
Gbondapi
Potoru
Zimmi
Fairo
Bo Waterside
Joru
Gola National Park
Pendembu
Foya City

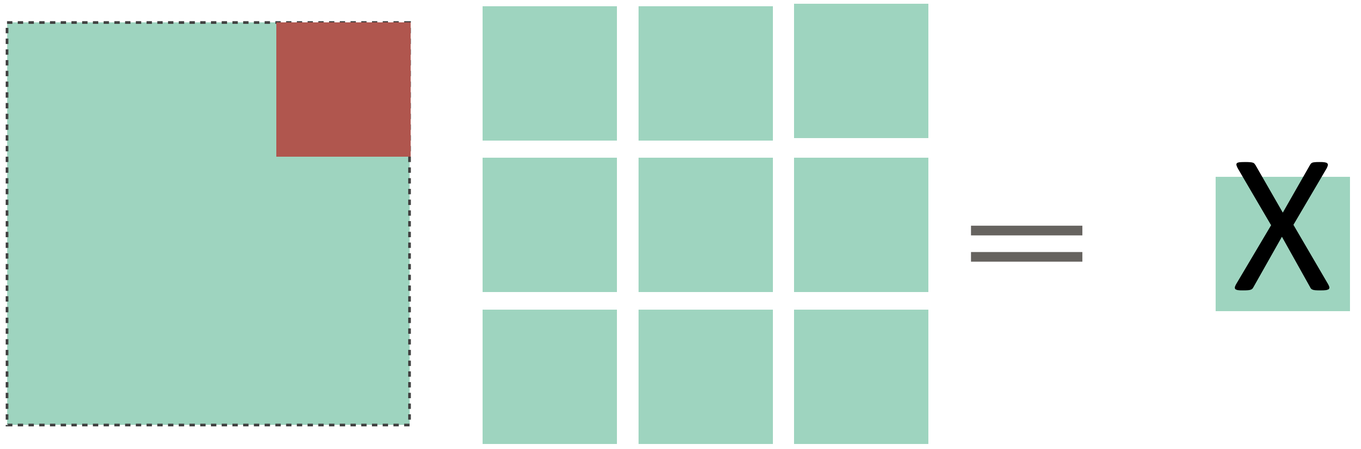
Global leakage

Treatment



–

Counterfactual



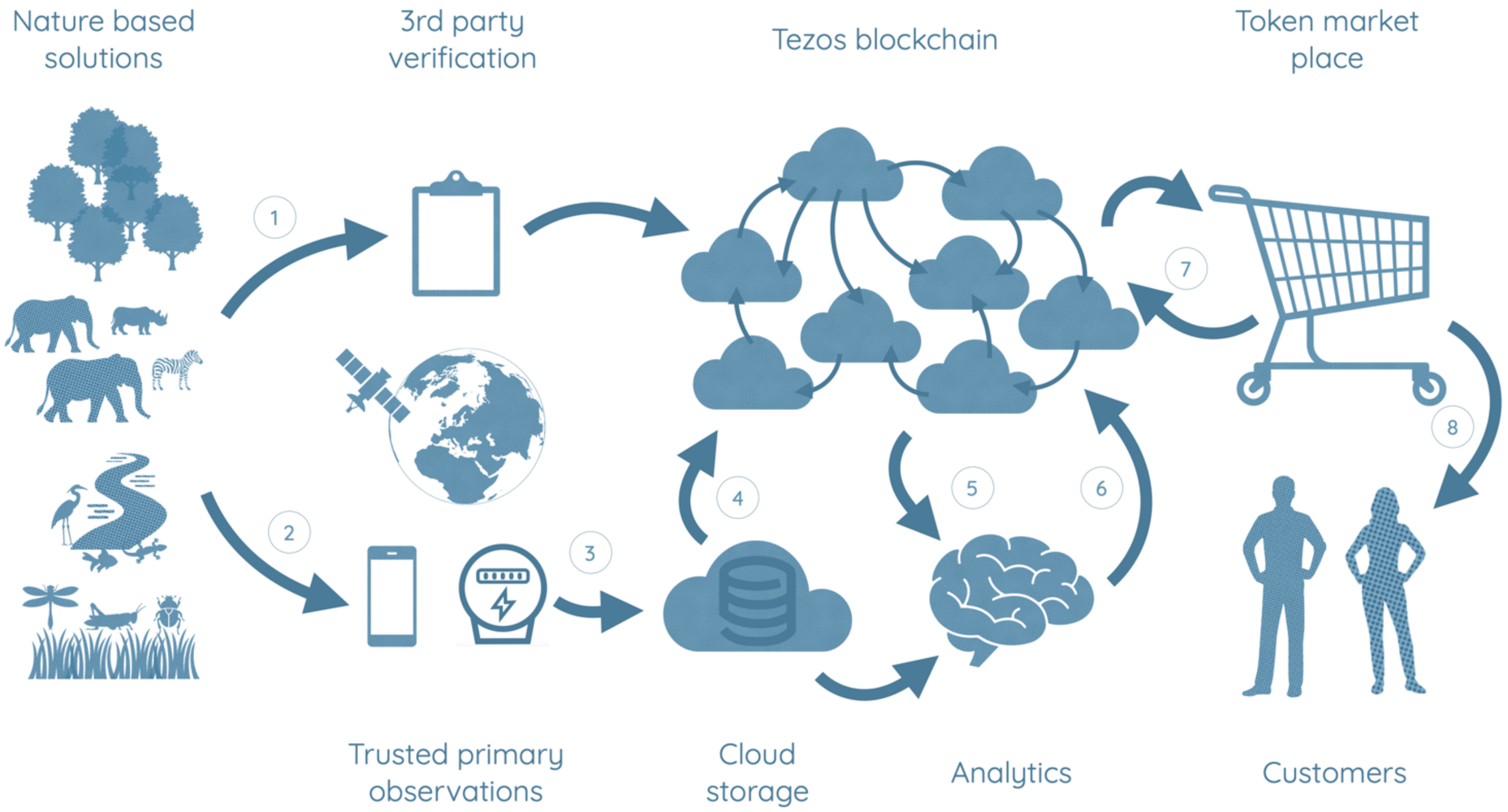
Valuing impermanence

- Nature-based solutions *defer* emissions
  - Do they have value?
- The *net damage* from 1 tonne of CO2 release is the *social cost of carbon (SCC)*
- The *value* of temporary sequestration = SCC(now) - discounted(SCC (time of release))
- Equivalent permanence = $\frac{\text{SCC(now) - discounted(SCC (time of release))}}{\text{SCC(now)}}$
- Time of release can be estimated from forest dynamics
  - forced
  - unforced

Metrics give us a counterfactual measure of the value of a project

Allow different NbS projects to be compared quantitatively

System

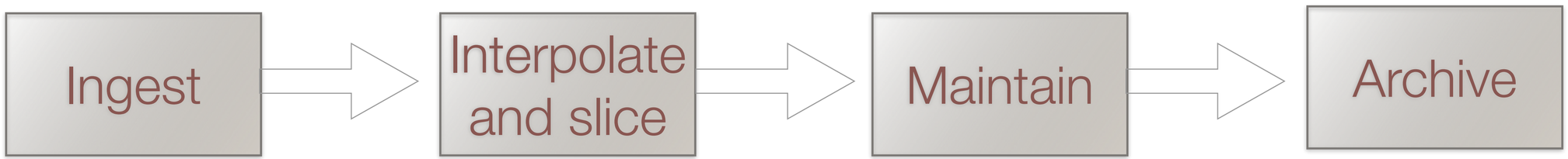

Nature based solutions
3rd party verification
Tezos blockchain
Token market place
1
2
3
4
5
6
7
8
Trusted primary observations
Cloud storage
Analytics
Customers

System requirements

- Support data analytics over petabytes of data
- Automated direct payments to data providers and project owners
- Ability to vet both credit providers and purchasers
- Algorithms and data reproducible and verifiable by third-parties
- Allow algorithms to evolve over time
- Must operate globally without a single entity controlling the network
- Must allow those impacted by a project to whistle blow anonymously

Needs advances in both analytics and systems

Data management requirements



Why blockchain?

- Doesn’t require universal trust in a single entity
  - who could that be?
- Provides immutability
- Bidirectional transparency
- Prevents double counting
- Automated direct global payments
  - if permitted!

Used for

- Proof of project ownership
- Additionality/leakage/permanence certification
- Tokens to prevent double counting
- Global fiat exchange
- Payments to data owner though smart contracts

Blockchain requirements

- Energy efficiency
- Flexibility
- Longevity

Energy efficiency

- Blockchains are famously energy inefficient
- Average daily user of Google is responsible for 0.008 CO2e/day

	CO2e/ transaction	Consensus
Bitcoin	1161.85 kg	PoW
Ethereum	127.05kg	PoW
Polygon	0.43 kg	PoS
Tezos	0.0025kg	PoS

Flexibility

- Needs to support smart contracts to
  - create tokens
  - exchange tokens for fiat
  - control access to token metadata
    - to hold additionality, leakage, and permanence values
- To scale, key consideration is gas fees, rather than transaction throughput or finality delay
  - PoS blockchains have lower gas fees due to lower energy costs

Longevity

- Blockchain longevity needs to be measured in decades
- Requires
  - Decentralisation
    - Failure of a single entity can cause failure of a centralised system
  - Liquidity
    - Provides participation incentives
  - Metaconsensus, i.e. consensus on how to choose consensus
    - Allows chain to evolve to incorporate new algorithms
- Tezos uniquely meets these requirements

Conclusions

- Nature based solutions address both the climate and biodiversity crises
  - Funding them through carbon credits is a good idea
  - but creating trust is critical
- Blockchain can help
  - in collaboration with environmental scientists
- This is the focus of 4C: Cambridge Centre for Carbon Credits
  - https://4c.cst.cam.ac.uk