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# The impact of climate change on coffee production in Central America

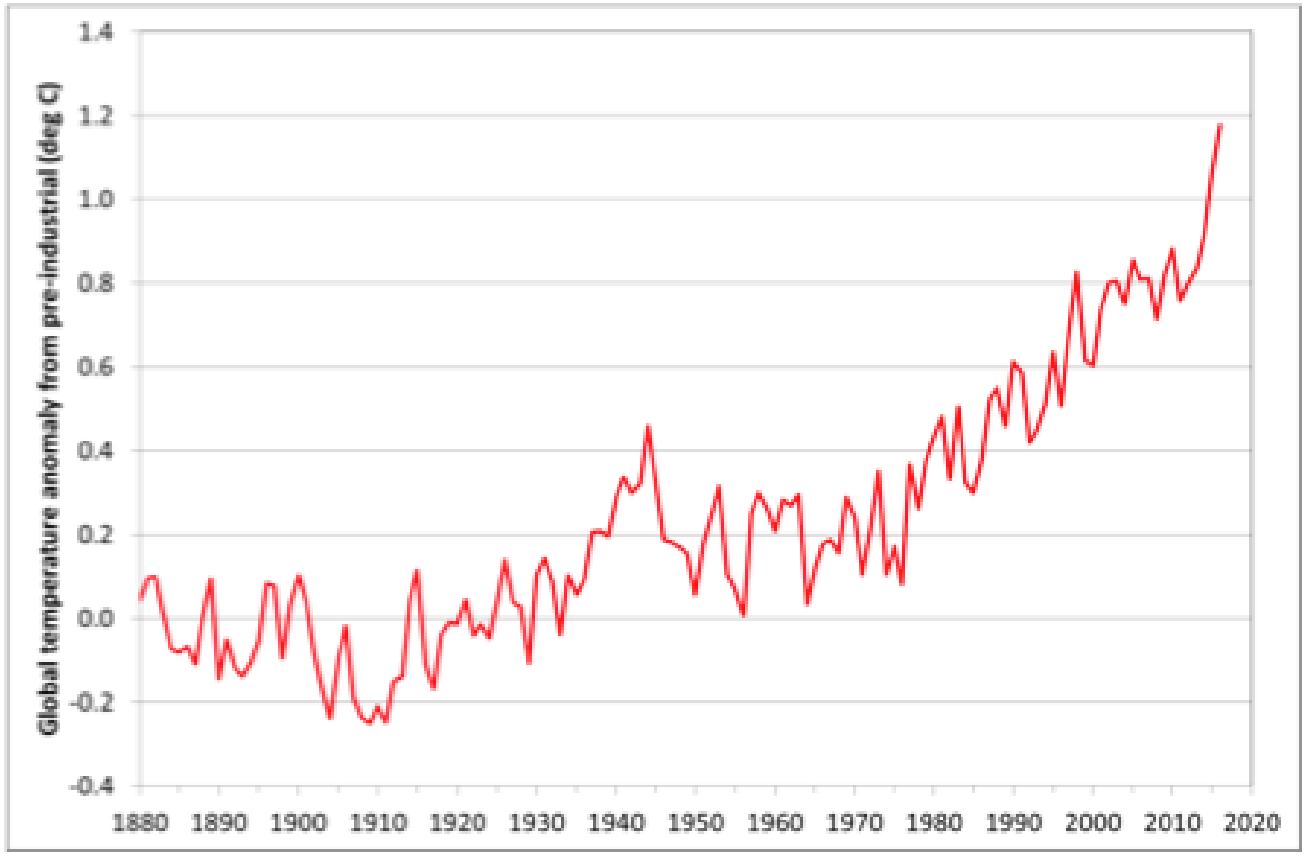
## Los impactos del cambio climático para el Café en Centro América

USAID FROM THE AMERICAN PEOPLE

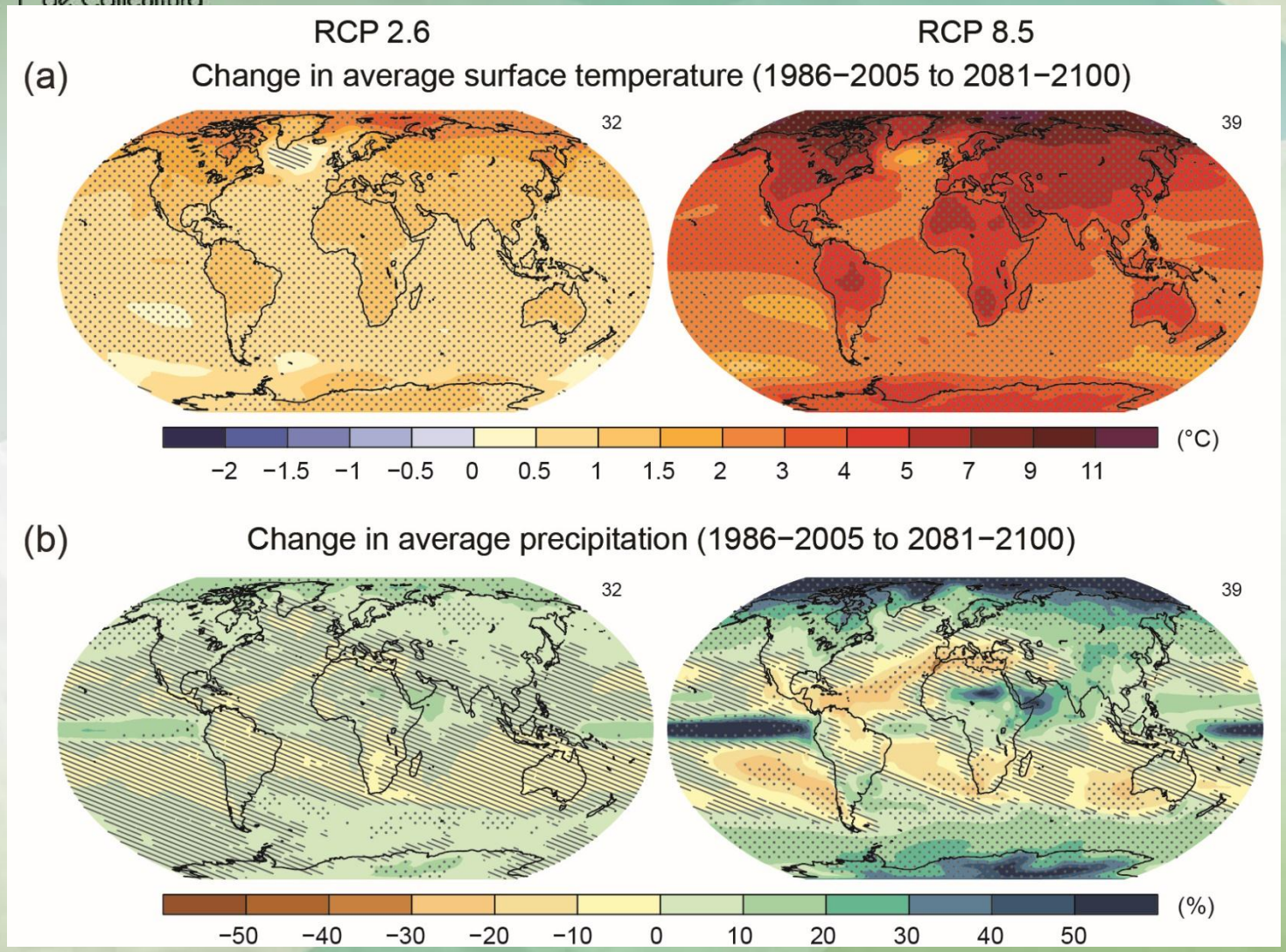
CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CCAFS

## Global temperatures – change from pre-industrial




Data: NOAA, NASA, UK Met Office/CRU


RCP 2.6
RCP 8.5
(a)
Change in average surface temperature (1986−2005 to 2081−2100)
32
39
(°C)
−2 −1.5 −1 −0.5 0 0.5 1 1.5 2 3 4 5 7 9 11
(b)
Change in average precipitation (1986−2005 to 2081−2100)
32
39
(%)
−50 −40 −30 −20 −10 0 10 20 30 40 50

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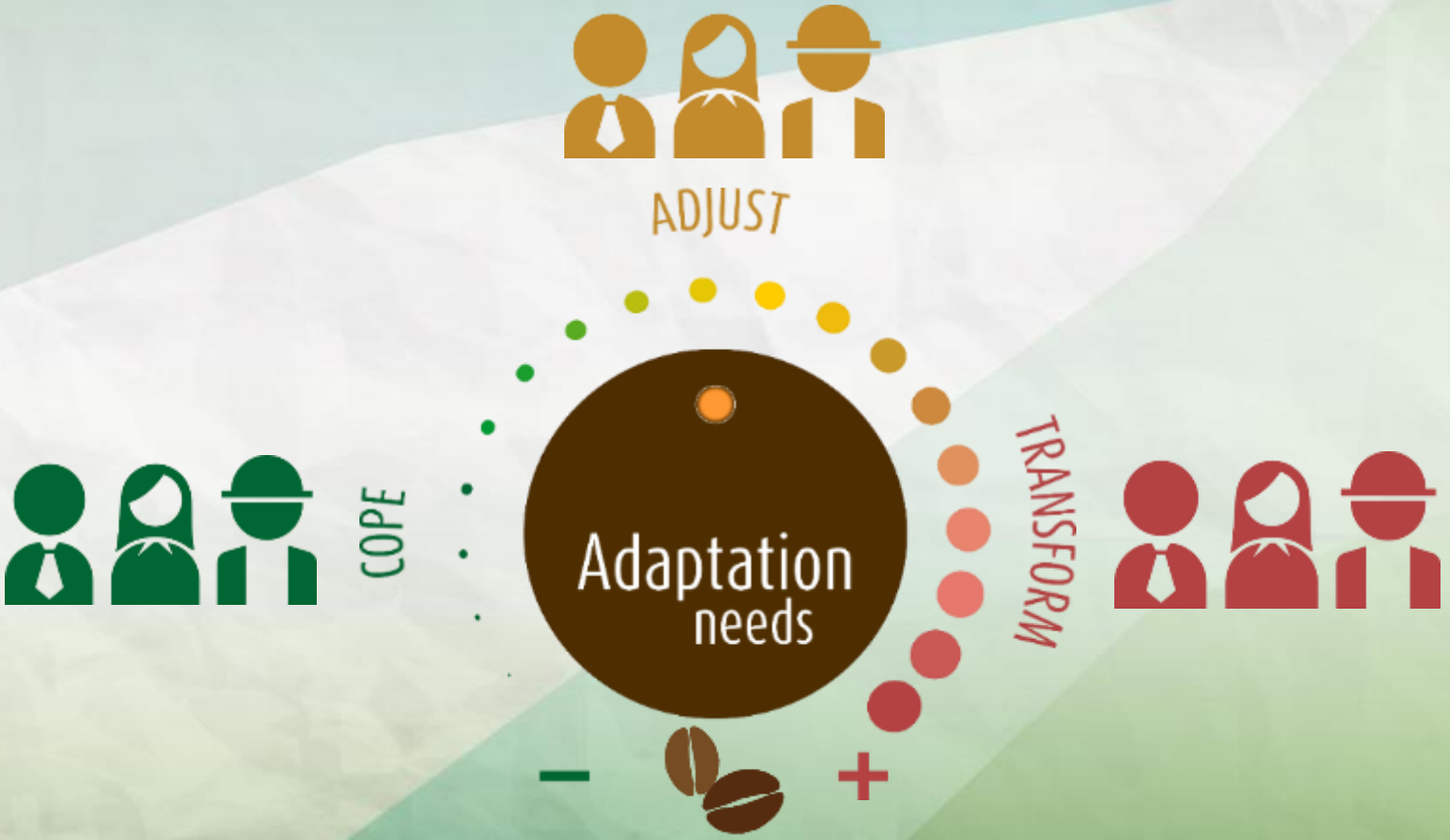
# Gradient of climate change impacts

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# Conceptual approach

- Coffee is currently produced under good climatic conditions
- We can learn from these locations and evaluate future data
- Machine learning approach:
  - Complex climate data
  - Missing climate data
  - Insufficient coffee physiological knowledge
  - High future uncertainty of precipitation projections

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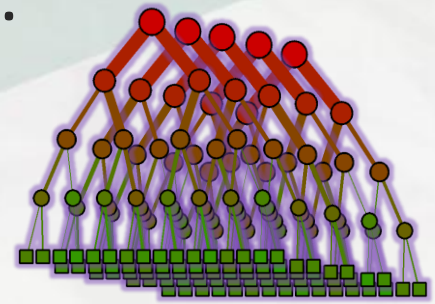
# Random Forests

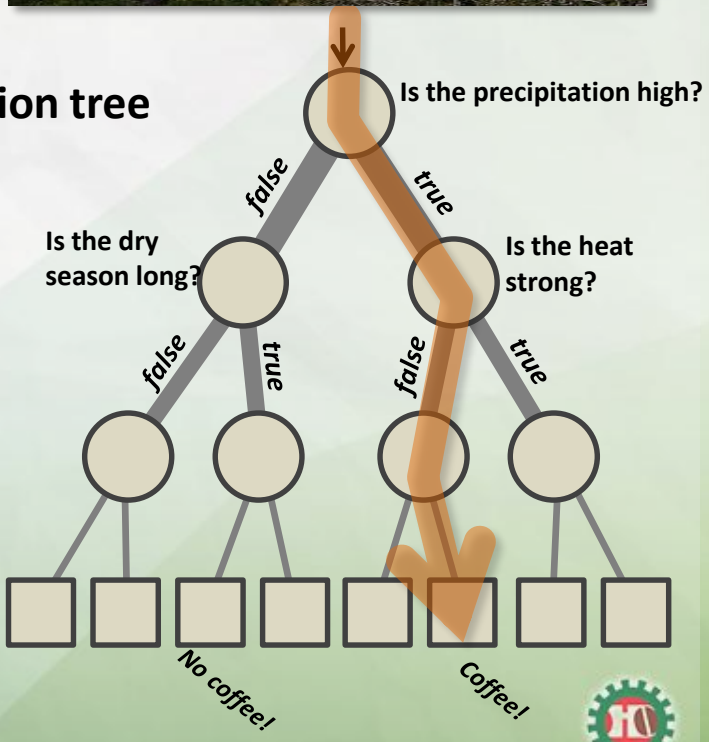
- A forest is an ensemble of trees. The trees are all slightly different from one another.



- The output is the mean classification

- Very robust against overfitting

**One decision tree**




Source: Criminisi et al 2013

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# Occurrences of coffee


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# Climate data

| Type | | Bioclimatic variable |
|---|---|---|
| Temperature | BIO 1 | Annual mean temperature |
| | BIO 2 | Mean diurnal range (mean of monthly (max temp - min temp)) |
| | BIO 3 | Isothermality (BIO2/BIO7) (*100) |
| | BIO 4 | Temperature seasonality (standard deviation *100) |
| | BIO 5 | Max temperature of warmest month |
| | BIO 6 | Min temperature of coldest month |
| | BIO 7 | Temperature annual range (BIO5-BIO6) |
| | BIO 8 | Mean temperature of wettest quarter |
| | BIO 9 | Mean temperature of driest quarter |
| | BIO 10 | Mean temperature of warmest quarter |
| | BIO 11 | Mean temperature of coldest quarter |
| Precipitation | BIO 12 | Annual precipitation |
| | BIO 13 | Precipitation of wettest month |
| | BIO 14 | Precipitation of driest month |
| | BIO 15 | Precipitation seasonality (coefficient of variation) |
| | BIO 16 | Precipitation of wettest quarter |
| | BIO 17 | Precipitation of driest quarter |
| | BIO 18 | Precipitation of warmest quarter |
| | BIO 19 | Precipitation of coldest quarter |

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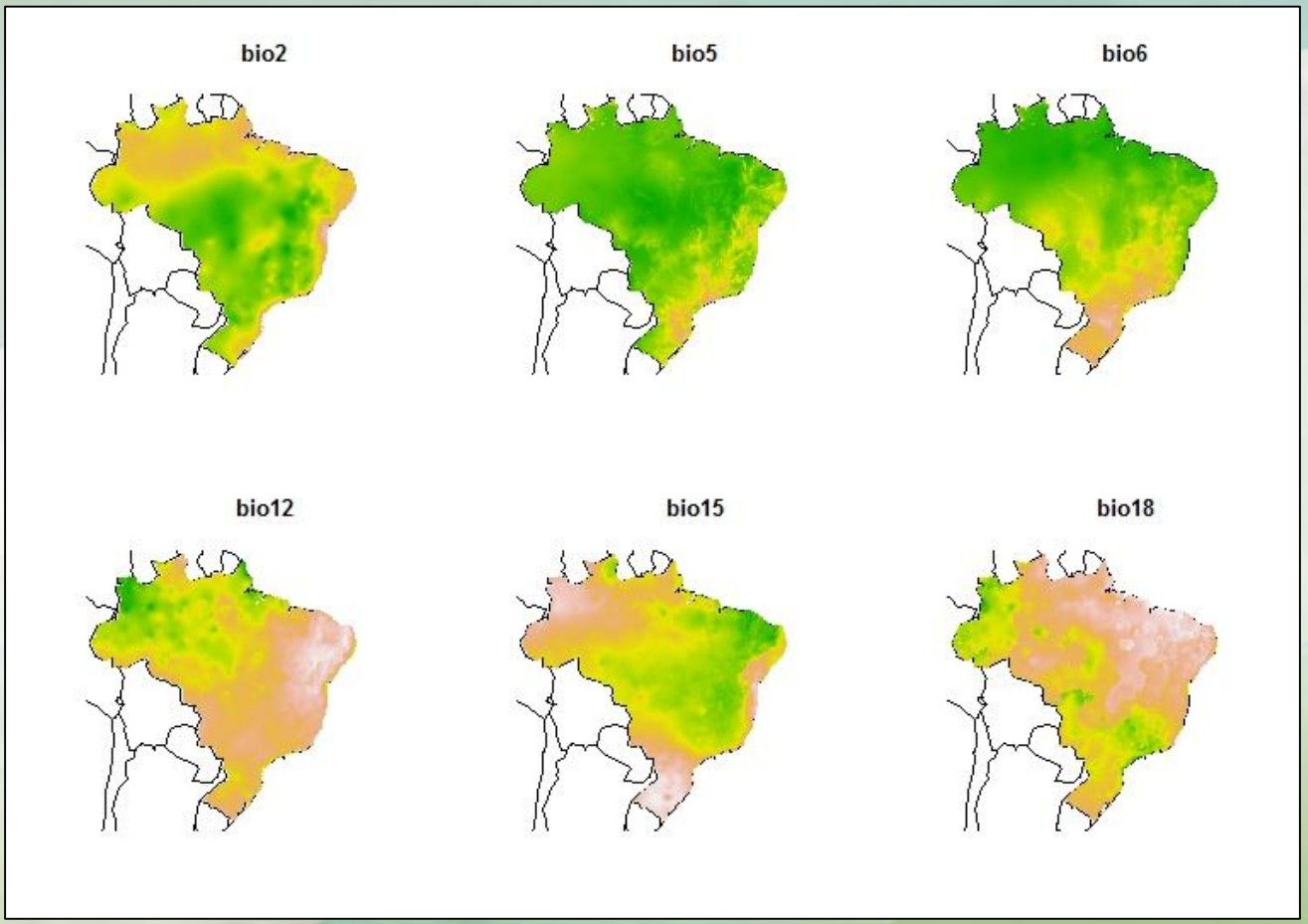
# Climate data

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# Climate types and drought

| Type | Precipitation of the driest quarter | Mean temp. of the driest quarter | Cons. months <40mm |
|---|---|---|---|
| **Type 1** | 44 | 22.1 | 4.3 |
| **Type 2** | 31 | 20.7 | 4.6 |
| **Type 3** | 22 | 20.8 | 3.4 |
| **Type 4** | 41 | 21.3 | 3.3 |
| **Type 5** | 89 | 23.2 | 1.6 |
| **Type 6** | 100 | 22.4 | 2.4 |
| **Type 7** | 38 | 18.7 | 3.8 |
| **Type 8** | 78 | 19.0 | 2.8 |
| **Type 9** | 176 | 22.1 | 0.5 |
| **Type 10** | 247 | 23.8 | 0.0 |
| **Type 11** | 184 | 21.1 | 0.6 |
| **Type 12** | 154 | 19.0 | 0.3 |
| **Type 13** | 172 | 18.7 | 0.0 |

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# Potential area


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# Gradient of climate change impacts


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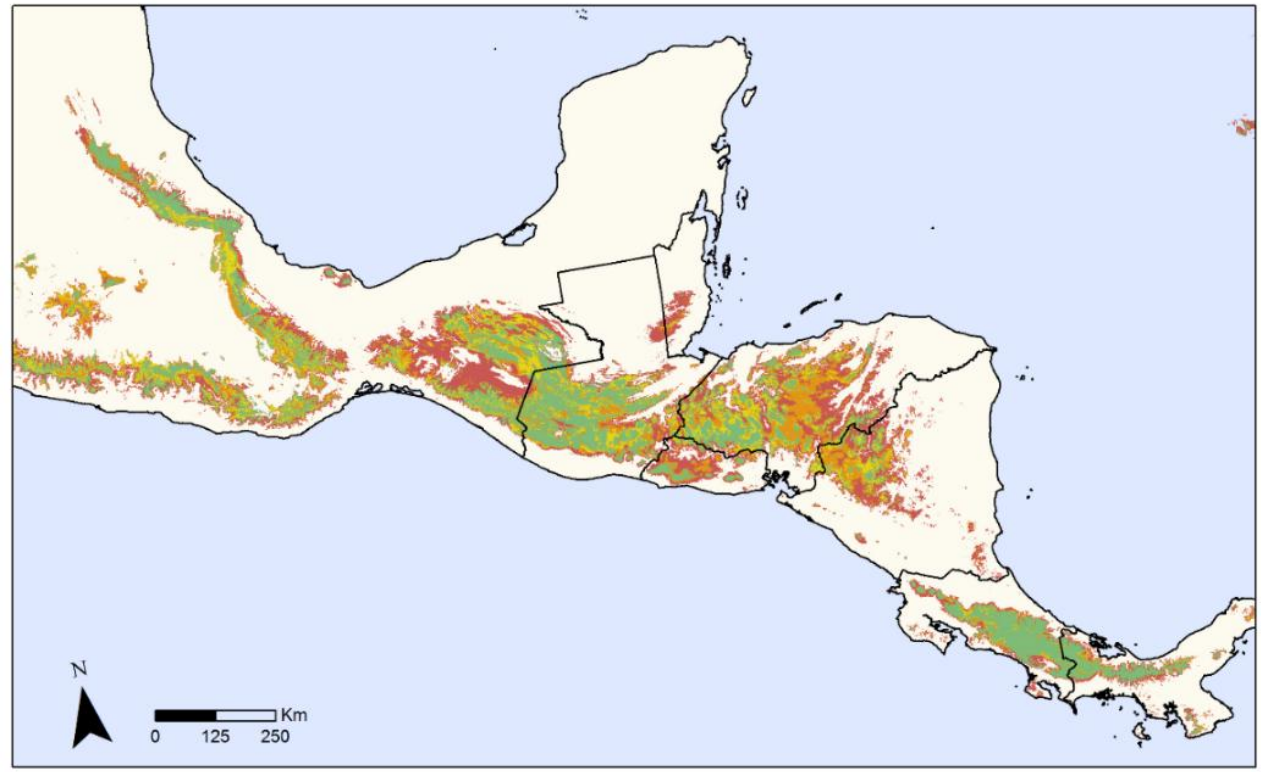
# Gradiente de impactos

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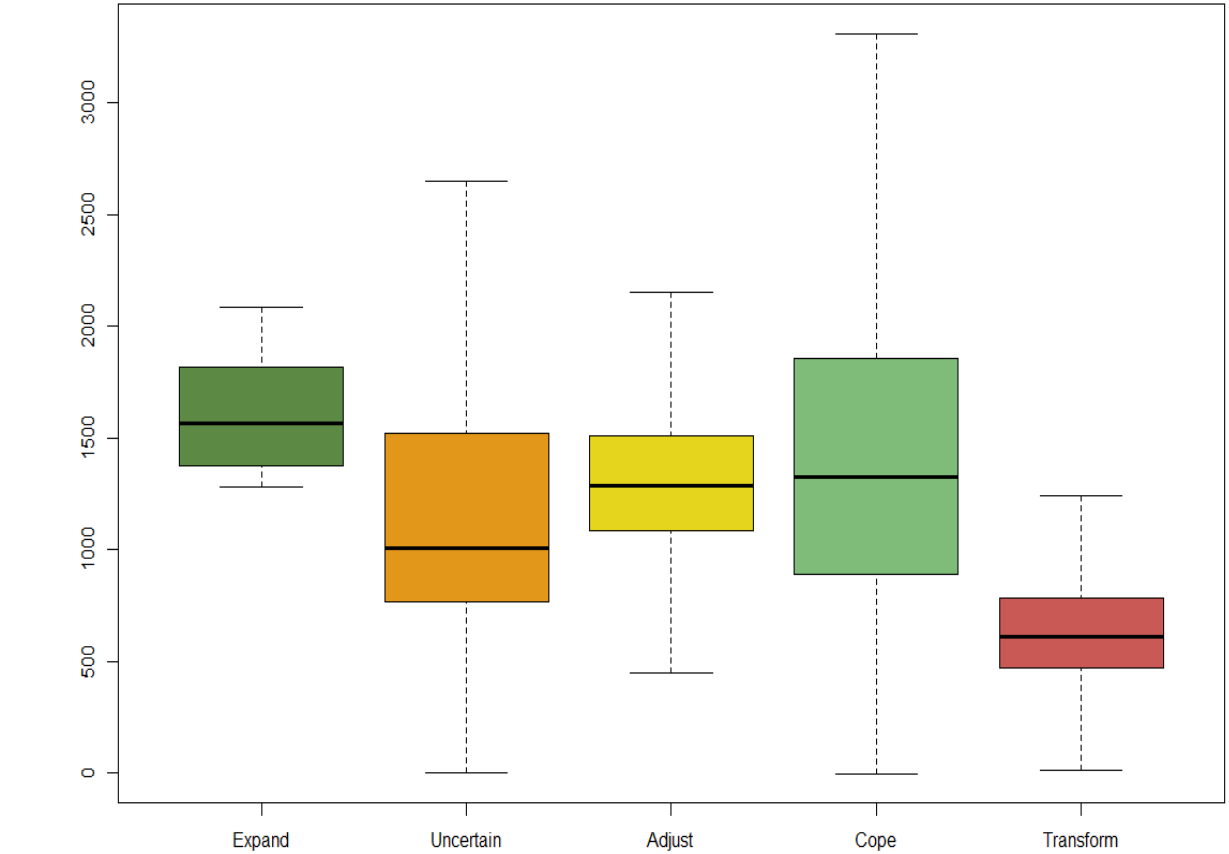
# Altitude and impacts

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# Conclusions

- One third each of potential coffee area
  - Transform
  - Systematically adapt
  - Cope
- Coffee will migrate upwards
- High uncertainty for dry climate zones
- In transformation zones producer need alternatives
- Public-private cooperation needed for systemic adaptation

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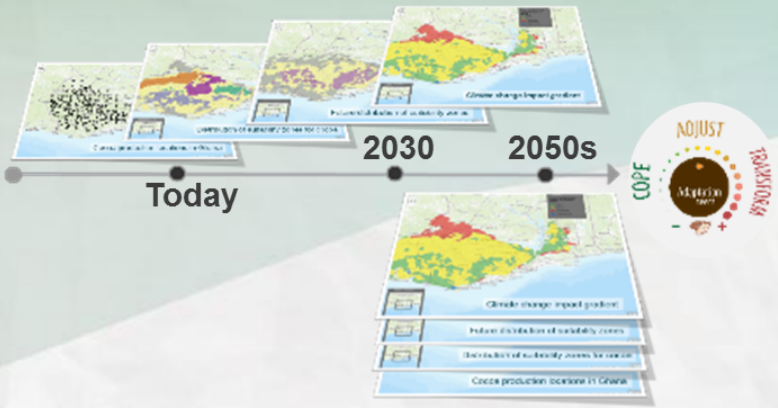
# Next steps

## 1 Map the impact gradient to understand the risk of climate change over time



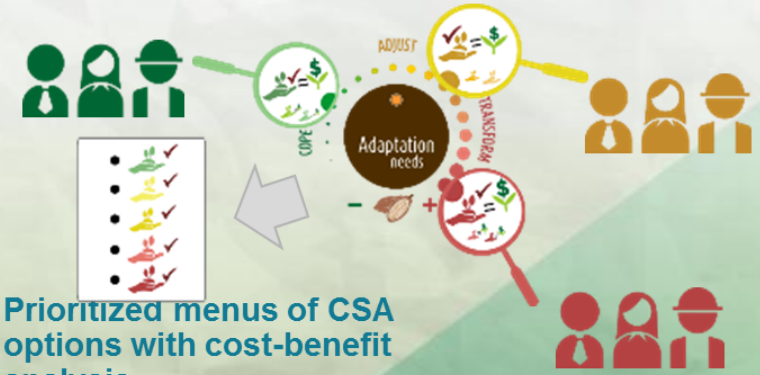

## 2 Convene value chain actors along the exposure gradient

Areas that transition from one suitability type to another but remain suitable


Locations where climate characteristics will not fundamentally change

Production in these zones will likely become unviable and other crops should be considered

## 3 Identify and prioritize relevant CSA practices by exposure gradient and analyze costs and benefits.




**Prioritized menus of CSA options with cost-benefit analysis**

## 4 Construct exposure specific portfolios of priority CSA practices for different investors

**Tailored CSA investment plans**

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Christian Bunn, F Castro, M Lundy – San Pedro Sula, Honduras August 2017

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