Soil Fertility Changes, Potentials and Vulnerabilities

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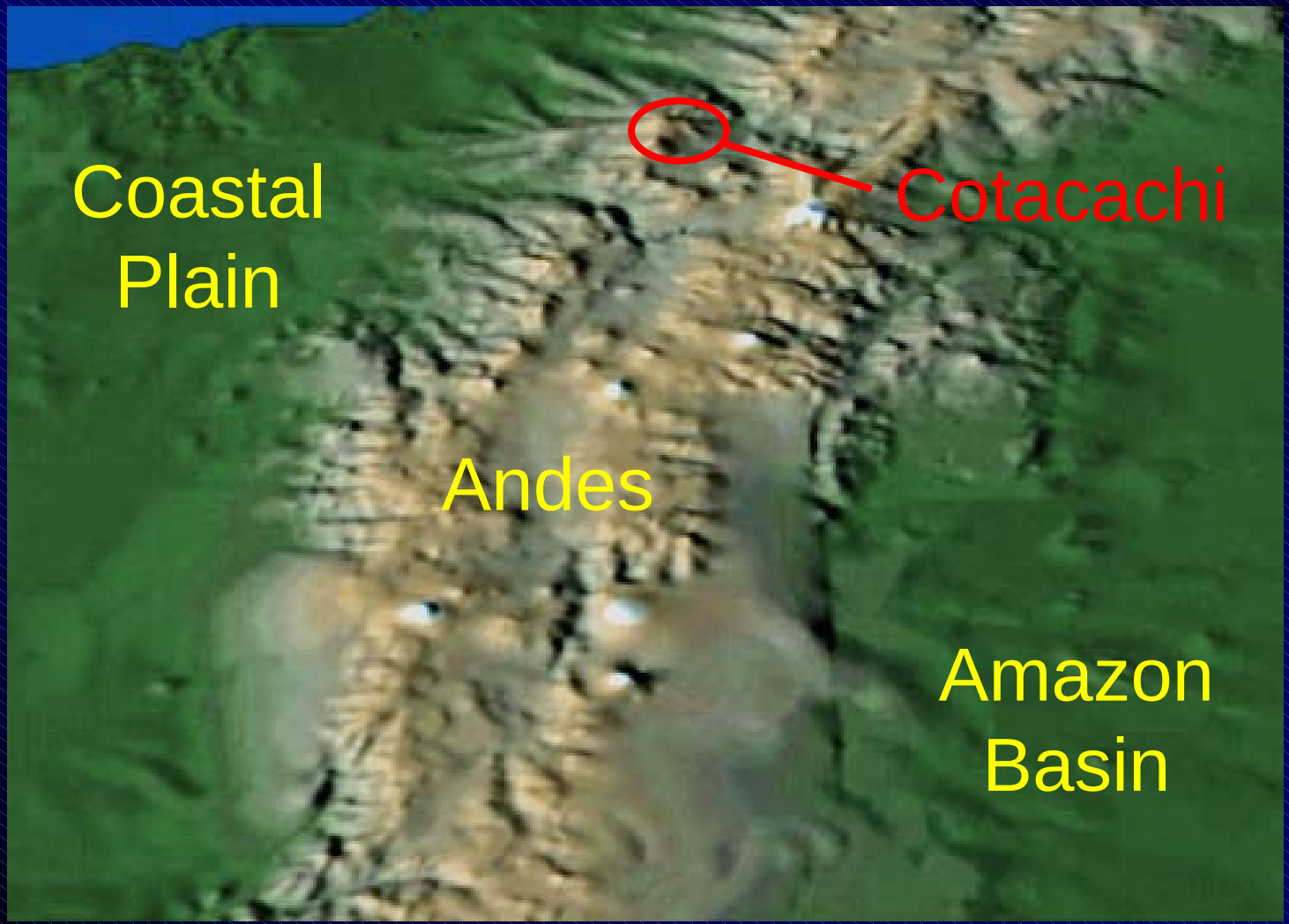
Relief of Ecuador
(as viewed from ~150 km)



http://www.peakware.com

Volcanic Soils

Reputation

- Fertile and highly productive
- High human-carrying capacity

However

- Inherent soil fertility depends on nature of volcanic deposits
- For sustainable productivity, proper management practices are prerequisite
- Continuous cropping without adequate inputs leads to nutrient mining and declining productivity

Soil Fertility Management in the Andean Eco-region

Traditionally

- Shifting cultivation Fallow-rotation systems
- Animal-based farming

Sarmiento et al., 1993; Schad, 1998; Pestalozzi, 2000; Phiri et al., 2001

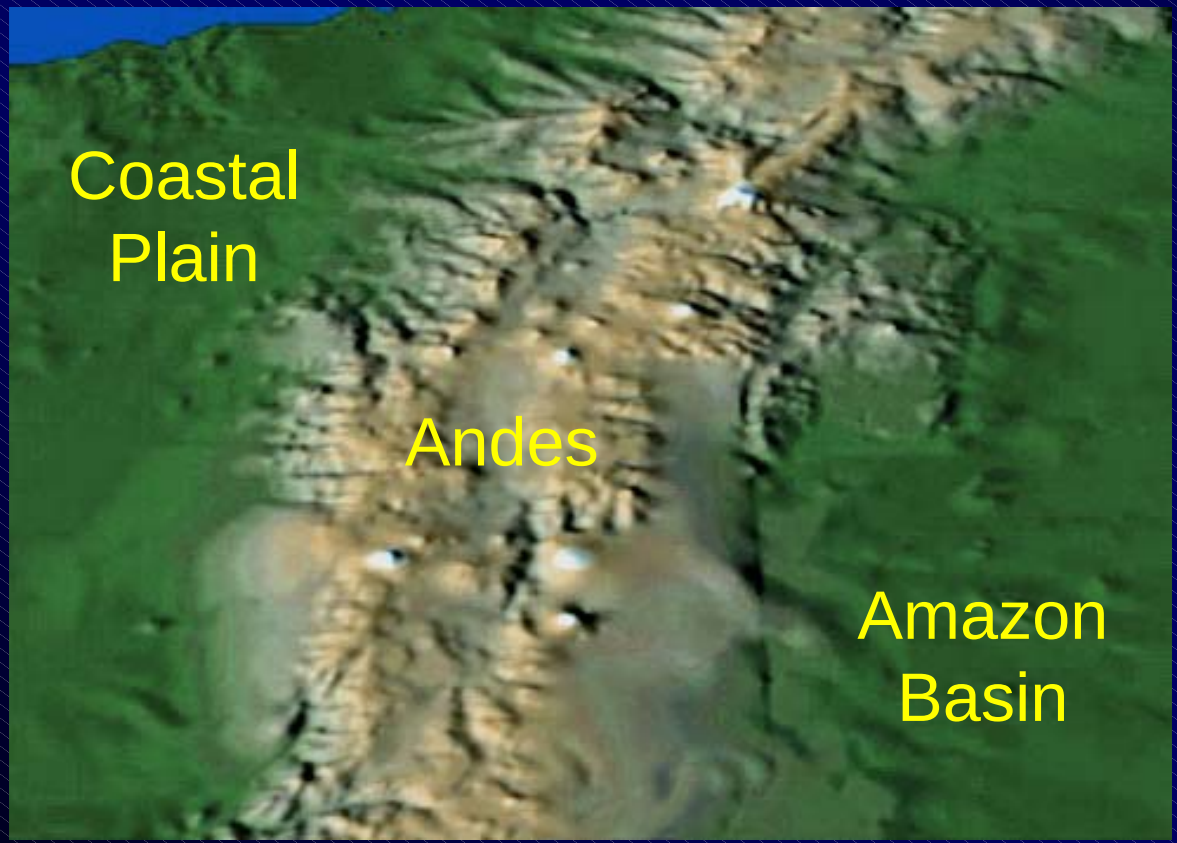
Changes due to

- Increasing population pressure
- Competing land-use demands
- Incorporation of elements from market-oriented agriculture

Sarmiento et al., 1993; Phiri et al., 2001

Modeling Nutrient Balances for Ecuadorian Agro-Ecosystems

de Koning et al. (1997)



Modeling Nutrient Balances for Ecuadorian Agro-Ecosystems

de Koning et al. (1997)

Nutrient depletion severest in Andean region

→ Andean agriculture NOT sustainable

Modeling Nutrient Balances for Ecuadorian Agro-Ecosystems

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Is this true for the Cotacachi area?
What are the drivers of such a downward trend?
How could the situation be improved?

Study Area

Vertical environment

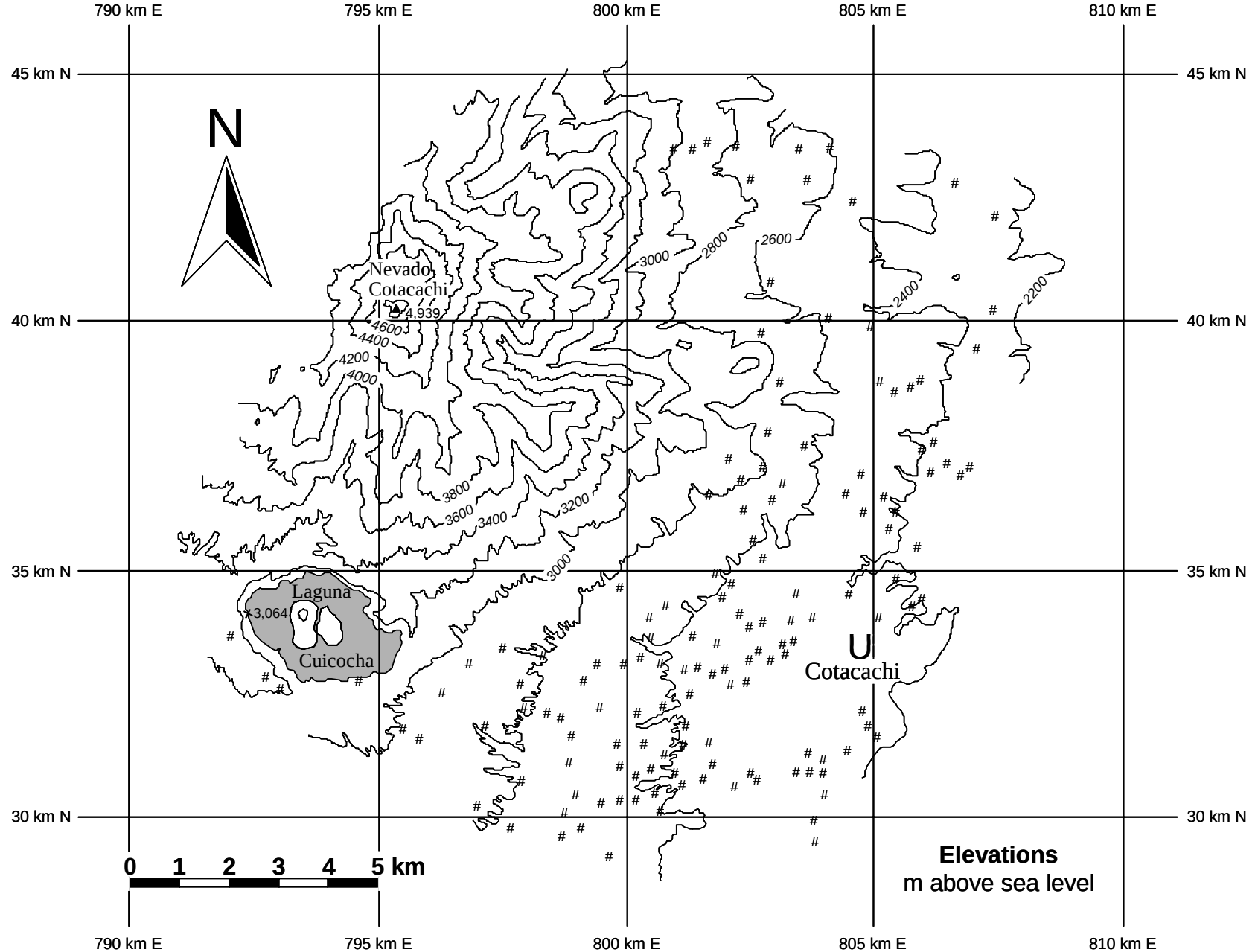
Landscape and lifescape change with elevation

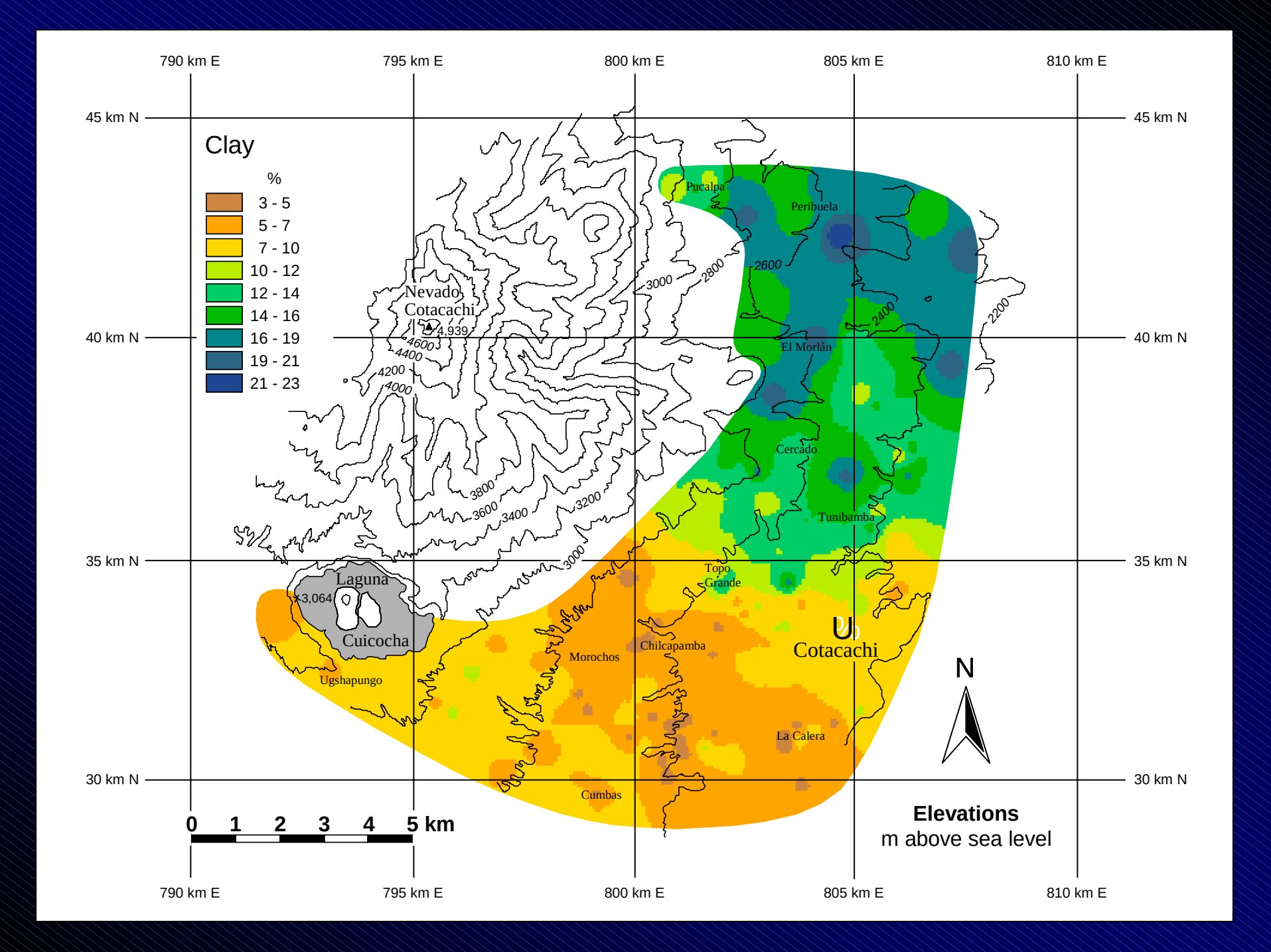
Reported Soil Fertility Decline

"Our ancestors used to harvest high crop yields, but now our soils don't produce any more …"

Objectives

- Analyze the fertility status of the soils in the Cotacachi area
- Identify limiting factors in different zones of the area
- Examine the long-term effects of nitrogen fertilization and residue management on crop yields


790 km E
795 km E
800 km E
805 km E
810 km E
45 km N
40 km N
35 km N
30 km N
N
Nevado
Cotacachi
4,939
4600
4400
4200
4000
3000
2800
2600
2400
2200
3800
3600
3400
3200
3000
Laguna
3,064
Cuicocha
U
Cotacachi
0 1 2 3 4 5 km
Elevations
m above sea level


790 km E
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30 km N
Clay
%
3 - 5
5 - 7
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10 - 12
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16 - 19
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Nevado Cotacachi
4,939
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Morochos
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La Calera
Cumbas
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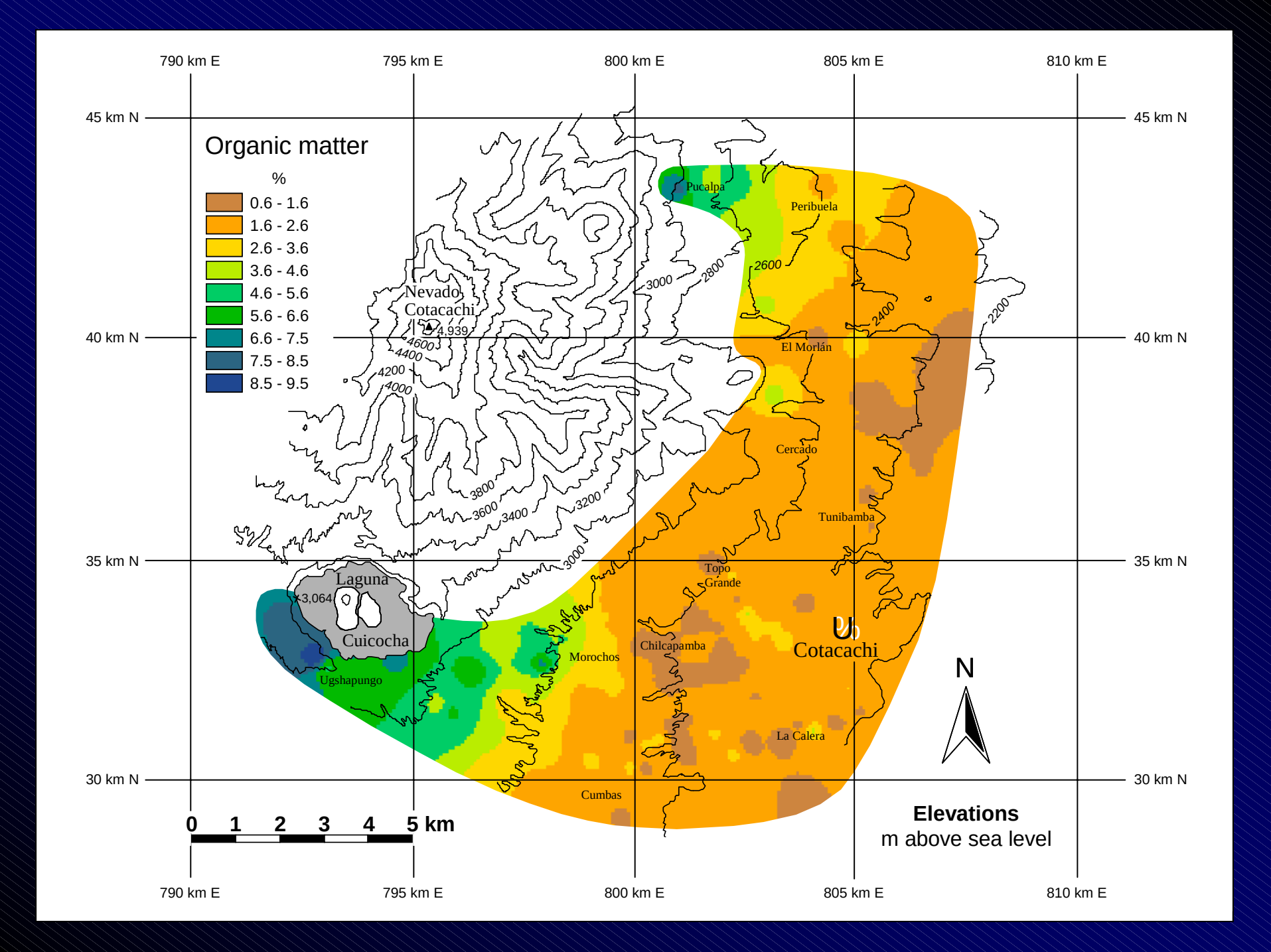
790 km E
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30 km N
Organic matter
%
0.6 - 1.6
1.6 - 2.6
2.6 - 3.6
3.6 - 4.6
4.6 - 5.6
5.6 - 6.6
6.6 - 7.5
7.5 - 8.5
8.5 - 9.5
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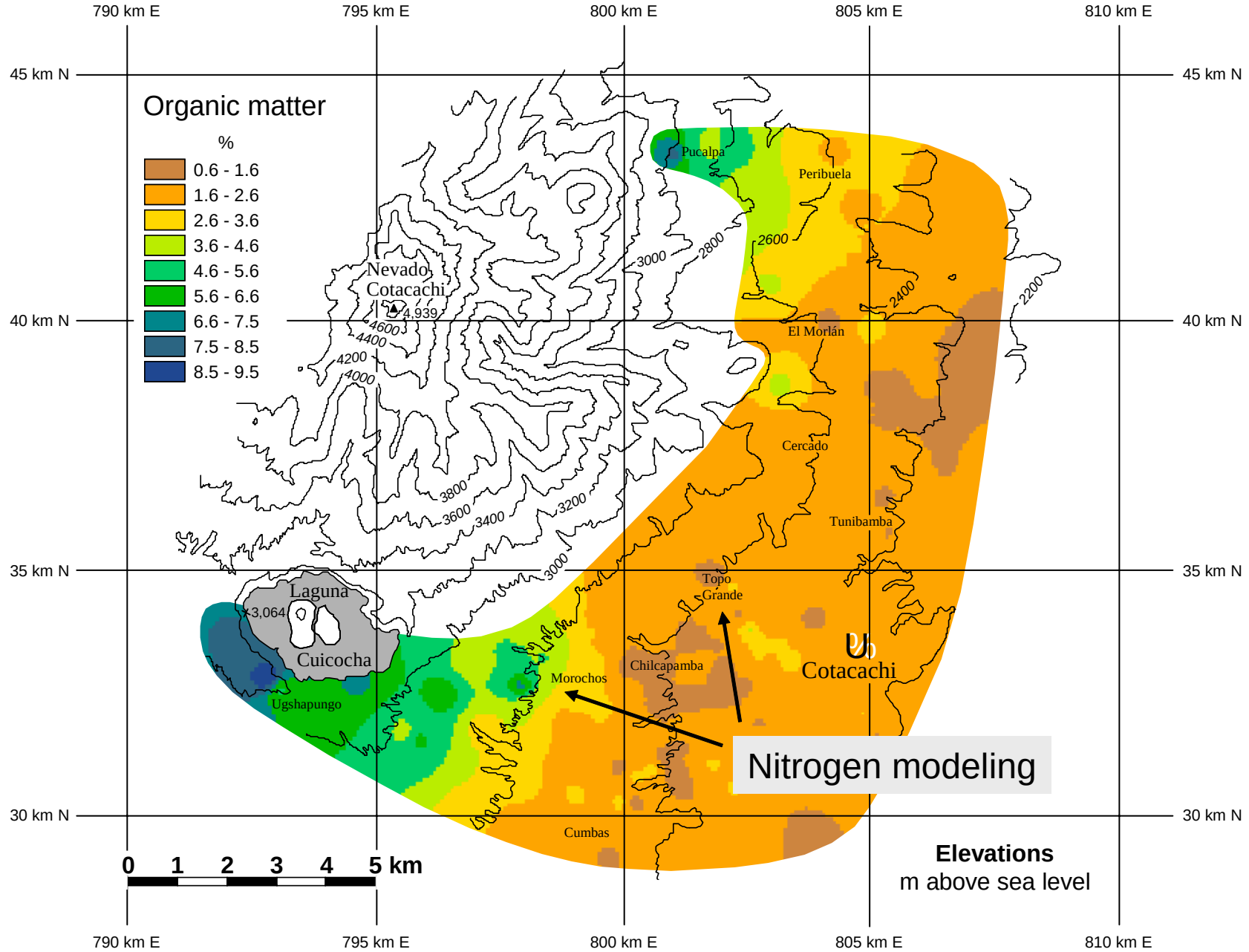
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Nitrogen modeling
0 1 2 3 4 5 km
Elevations
m above sea level

Nitrogen Modeling

DSSAT (CERES-Maize)

- 30 years of weather data were generated (WGEN)
- An annual maize-fallow rotation was simulated
- Nitrogen cycling was modeled,
  all other factors were assumed not limiting

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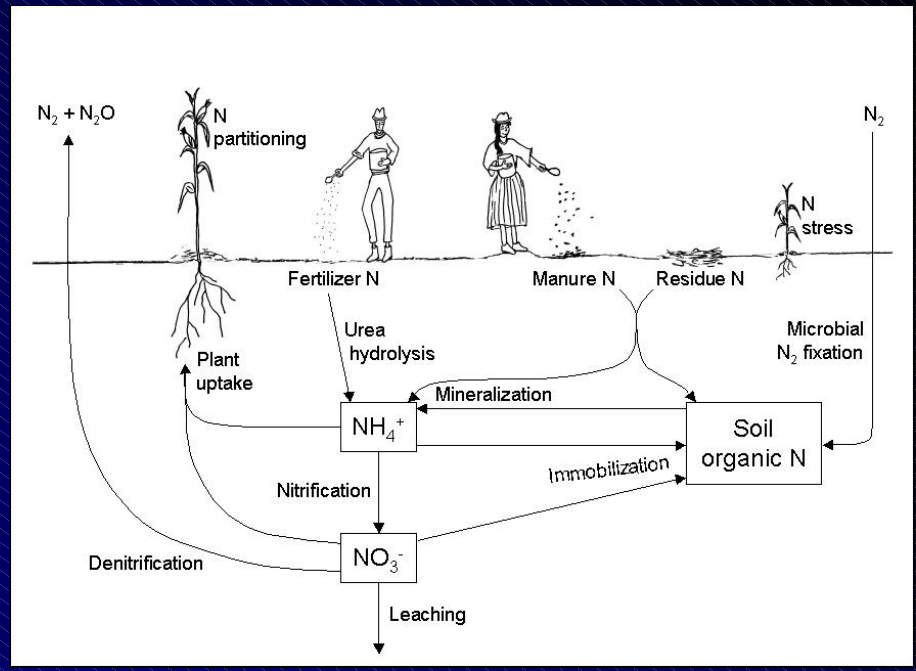

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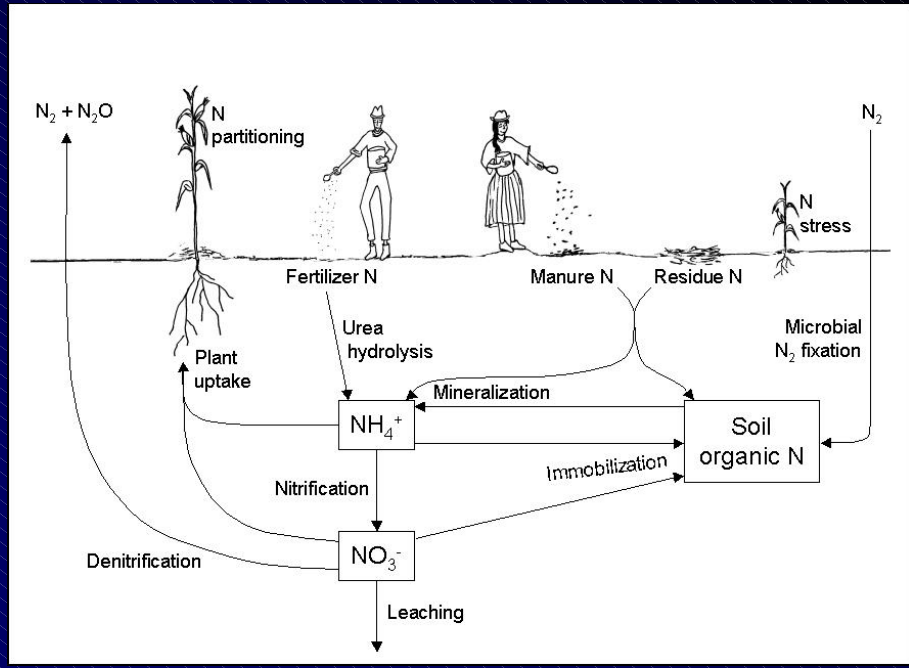

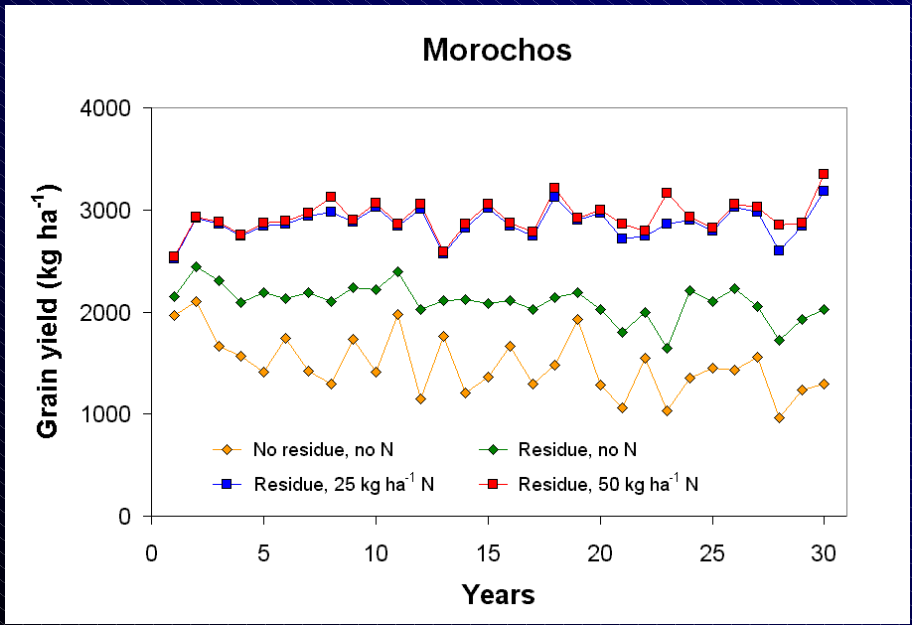

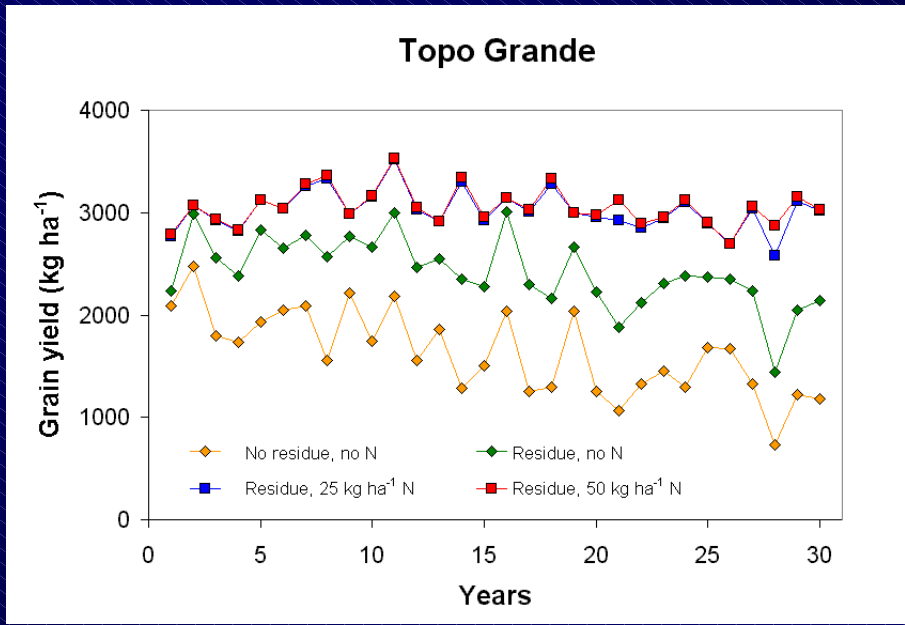

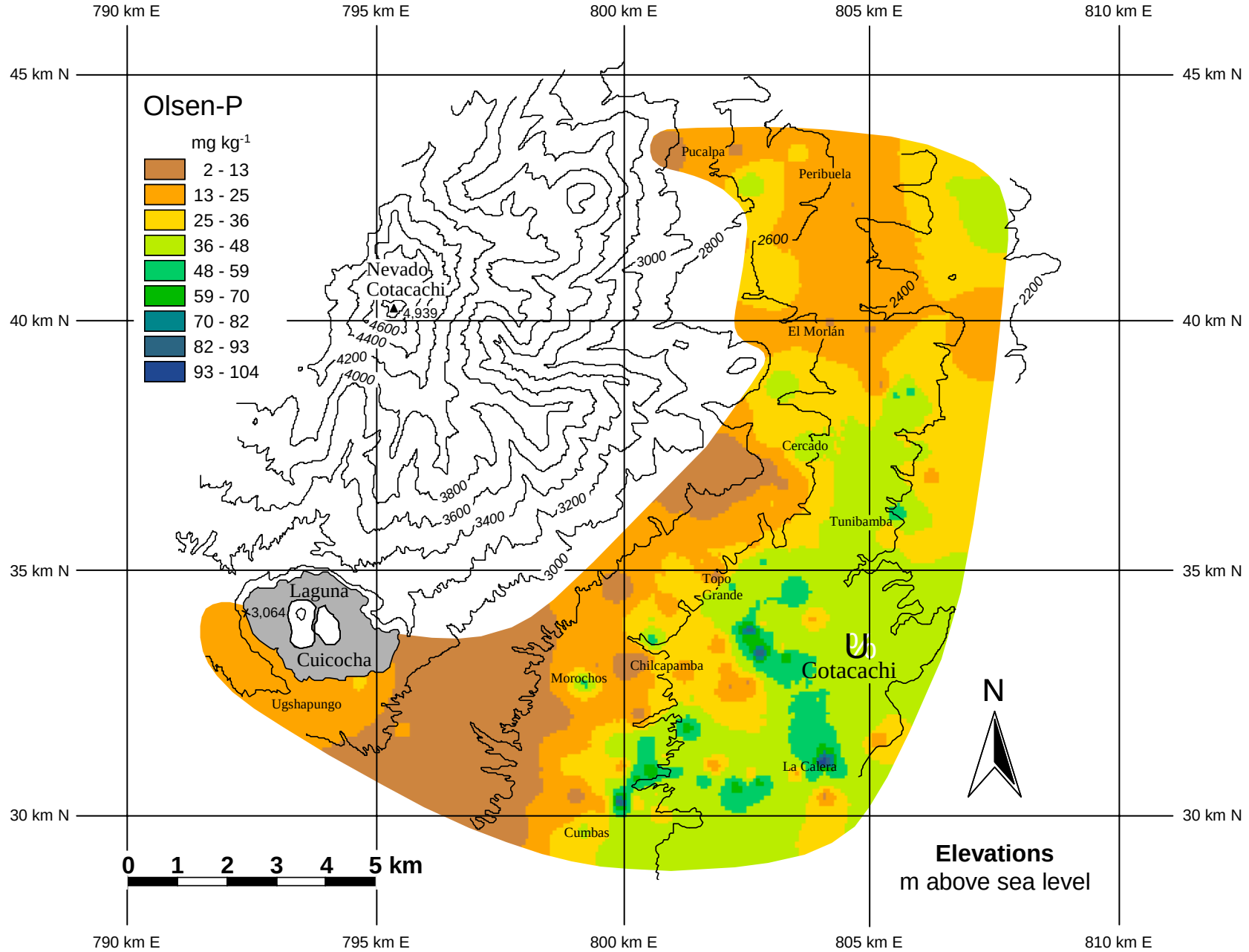
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Olsen-P
mg kg-1
2 - 13
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25 - 36
36 - 48
48 - 59
59 - 70
70 - 82
82 - 93
93 - 104
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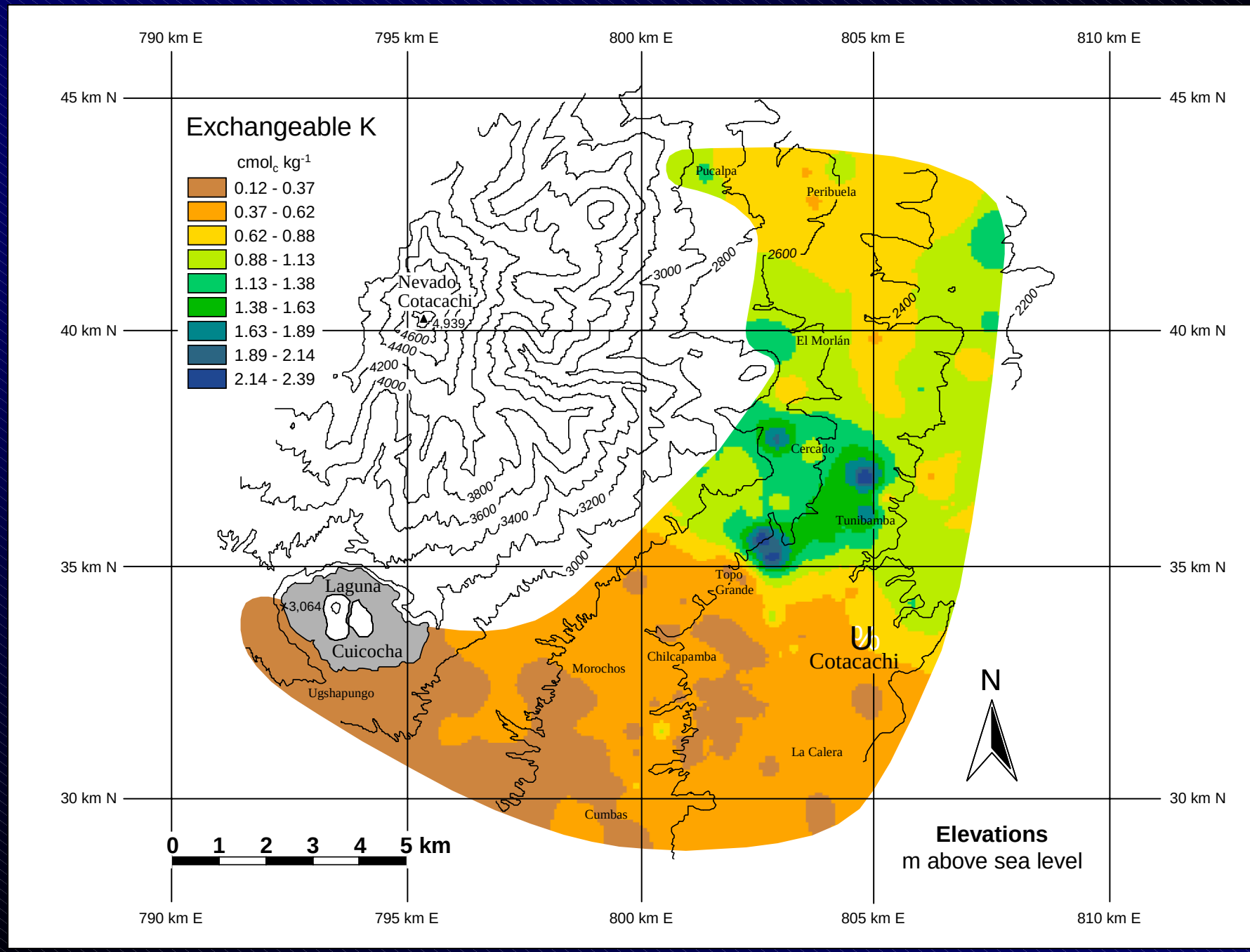
Exchangeable K
cmol$_c$ kg^{-1}
0.12 - 0.37
0.37 - 0.62
0.62 - 0.88
0.88 - 1.13
1.13 - 1.38
1.38 - 1.63
1.63 - 1.89
1.89 - 2.14
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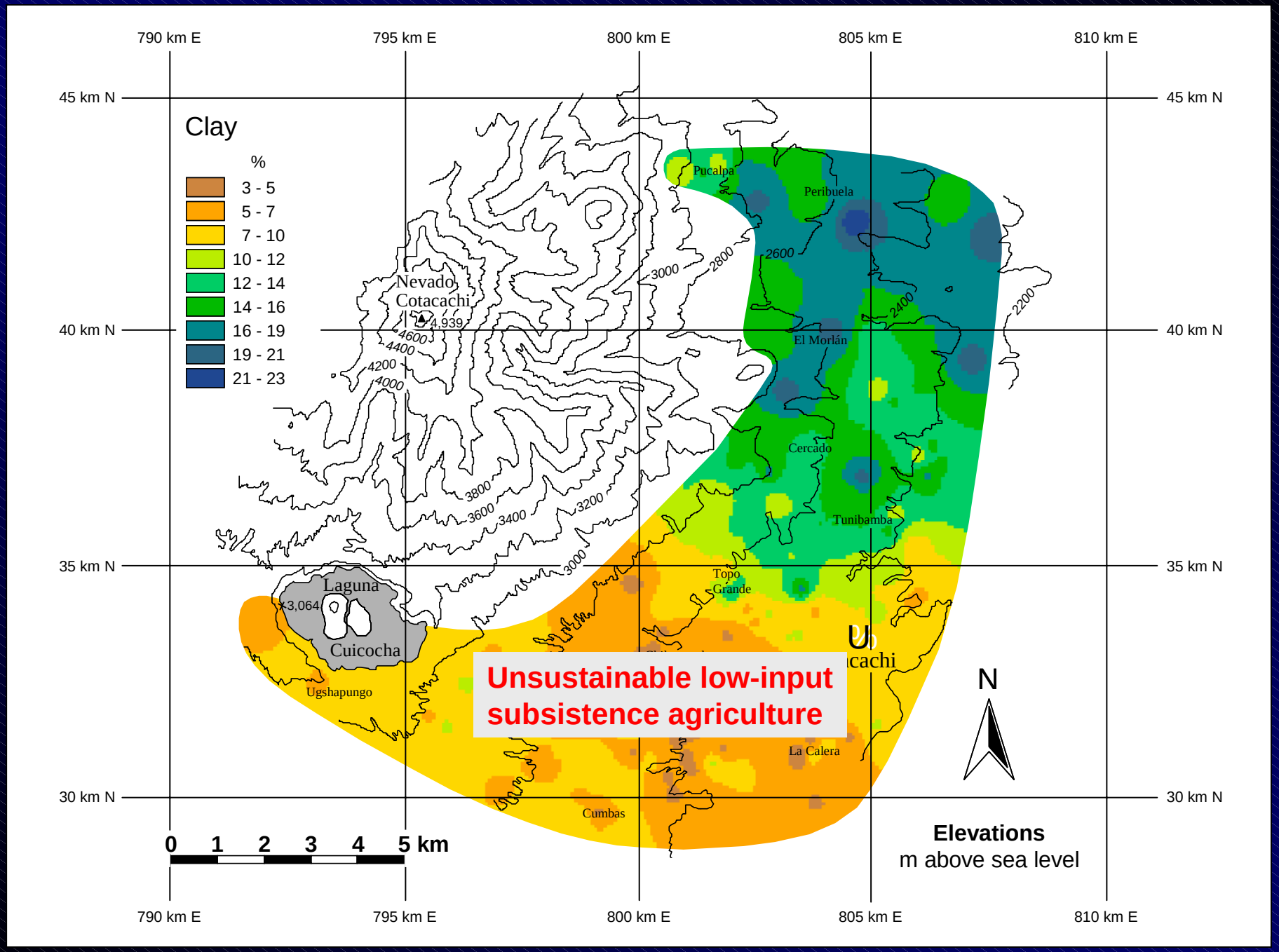
How could the situation be improved?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Unsustainable low-input subsistence agriculture
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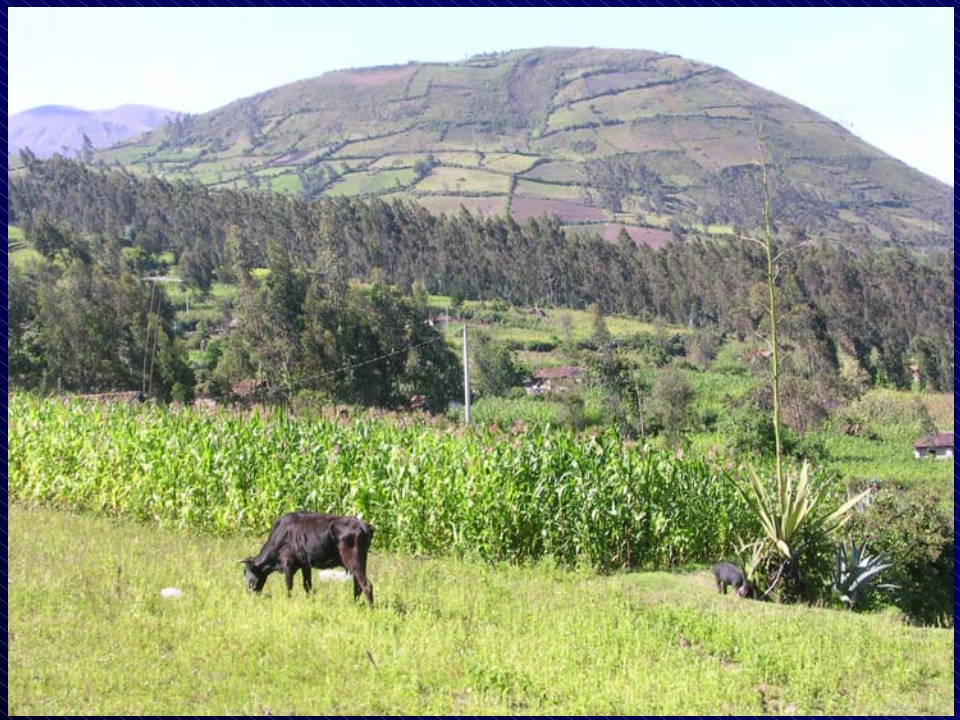
Trends in Agriculture



- Division of land among many children
  - → Limited amounts of available land
  - → Less shifting cultivation
- Theft of livestock
  - → Less animal-based farming
- No resources for fertilization
  - → Soil fertility decline … ***Spiral of un-sustainability***

Socio-economic Trends

- Desire to improve living conditions
  → Need for income generation
- Difficult for peasant farmers to compete with *haciendas* and products from Colombia on markets
  → More extra-agricultural occupations
  - Construction work
  - Crafts (weaving)
  - Eco-tourism

Is agriculture not as important any more?

Inti Raimi

Tunibamba
June 2000

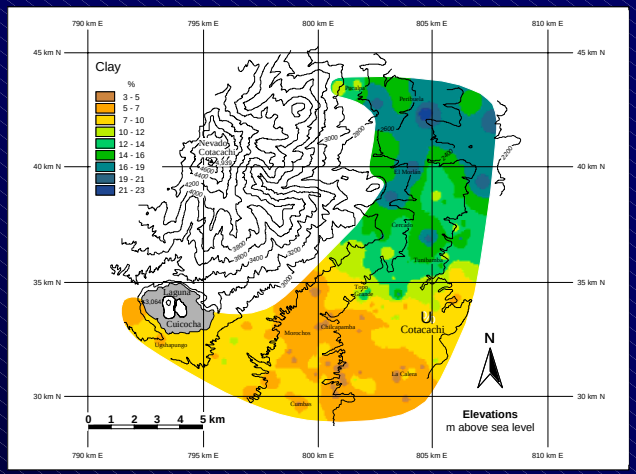
Indigenous tradition and identity are deeply intertwined with agriculture

UNORCAC

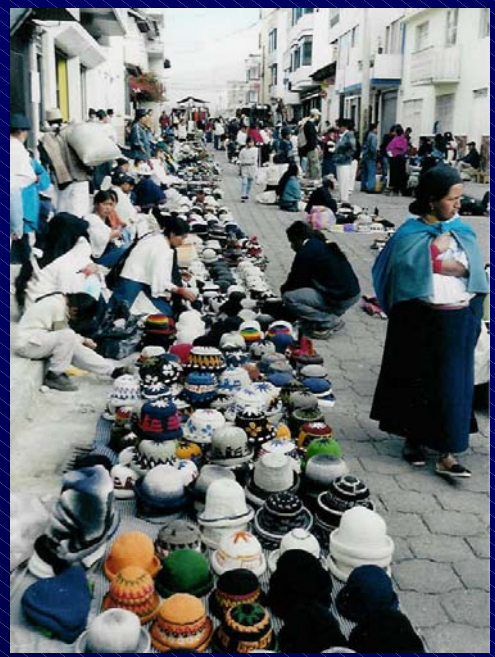
How could the situation be improved …?

- The soils are potentially productive
- Adequate management practices are required
  - Nutrient losses need to be minimized
  - Nutrients that leave the system need to be replaced
- Several avenues of restoring soil fertility
- Economically viable pathways to sustainability
  - Specialization, e.g. high-value fruits, vegetables
  - Organic farming, e.g. quinua for external markets
  - Eco-tourism

Lessons Learned



Complex environments



Integrated approaches

Gracias

- SANREM team
- UNORCAC
- People in the Cotacachi communities