Systems Analysis for Policies

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International Institute for Applied Systems Analysis (IIASA)
Laxenburg, Austria

United Nations/Austria/European Space Agency Symposium on
Space Tools for Protecting Air Pollution and Energy Use for Sustainable Development
Graz, Austria, 12–15 September 2006

IIASA Mission

To conduct scientific studies to provide timely and relevant information and options, addressing critical issues of global environmental, economic, and social change for the benefit of the public, the scientific community, national governments, and national and international institutions

(IIASA enters the 21st century, p. 1)

IIASA Goals

- Provide timely and relevant information and policy analyses for:
  - the scientific community
  - national and international institutions
  - industry and the public
- Address critical global issues in an innovative manner

2006–2010:
Environment and Natural Resources Theme

Atmospheric Pollution and Economic Development (APD) Program

- will do interdisciplinary research to develop modeling tools for supporting strategies in order to protect local, regional and global atmosphere with least burden on economic development

Evolution and Ecology (EEP) Program

- will do interdisciplinary research on human-induced evolutionary changes in exploited fish stocks and on impact of environmental disturbances on the structure and functioning of food webs

Forestry (FOR) Program

- will do interdisciplinary research on three major areas of the management of the forest sector
  - greenhouse gas cycling and terrestrial ecosystems
  - global impacts of forest sector development in emerging economies
  - international governance of forests

Land Use Change and Agriculture (LUC) Program

- will do interdisciplinary research on agro-ecosystem services as food, fiber, carbon, bioenergy and with special emphasis on food security and rural livelihoods, sustainable soil and water resources and impacts of climate change

2006–2010: Energy and Technology Theme

Energy (ENE) Program

- will do interdisciplinary research on three major areas
  - global energy assessment
  - energy modeling
  - investments and financing in energy

Transitions to New Technologies (TNT) Program

- will do interdisciplinary research on
  - describing the diffusion of new technologies in time and space
  - assessing economic, social and environmental implications of technology diffusion
  - assisting policy making on technological innovation and diffusion

Dynamic Systems (DYN) Program

- will do interdisciplinary research on large scale dynamic systems with emphasis on
  - methodology development
  - technology and energy development
  - environmental dynamics

2006–2010: Population and Society Theme

World Population (POP) Program

- will do interdisciplinary research on population dynamics and population-environment interactions focusing on three issues
  - population forecasting
  - population characteristics and human capital
  - population and environment

Population and Climate Change (PCC) Program

- will do interdisciplinary research on integrated assessments of climate change with respect to
  - influence demographic change on emissions
  - the role of uncertainty and learning
  - medium-term response strategies

Risk and Vulnerability (RAV) Program

- will do interdisciplinary research to contribute to decrease the risk and vulnerability of societies and ecosystems (vulnerability consider multiple stress and system resilience) by addressing four goals
  - methodological development of risk and vulnerability models
  - case studies on risk and vulnerability assessments
  - integrative stakeholder led case studies
  - develop interactive tools for training on vulnerability and adaptation

Processes of International Negotiation Network (PIN) Program

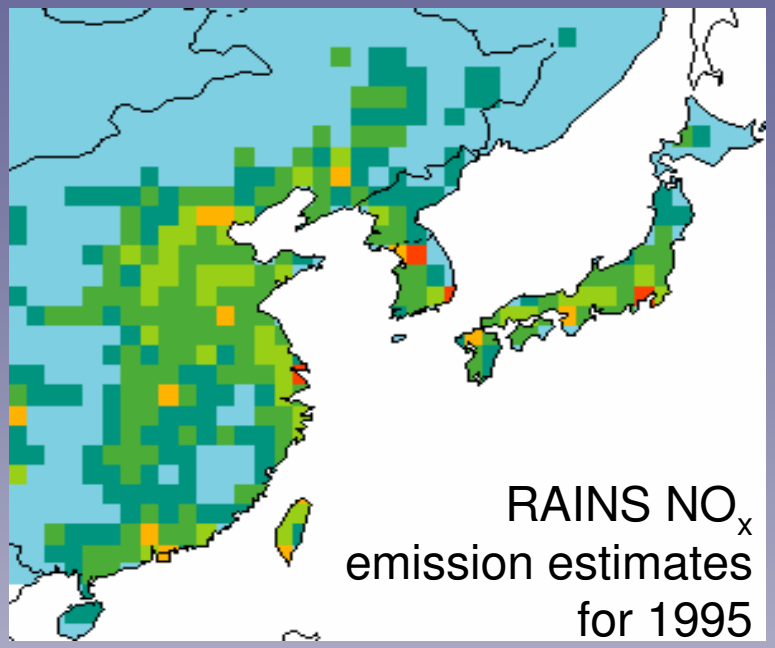
- will do interdisciplinary research in order to facilitate or support international negotiations on disputes, conflicts and international regimes

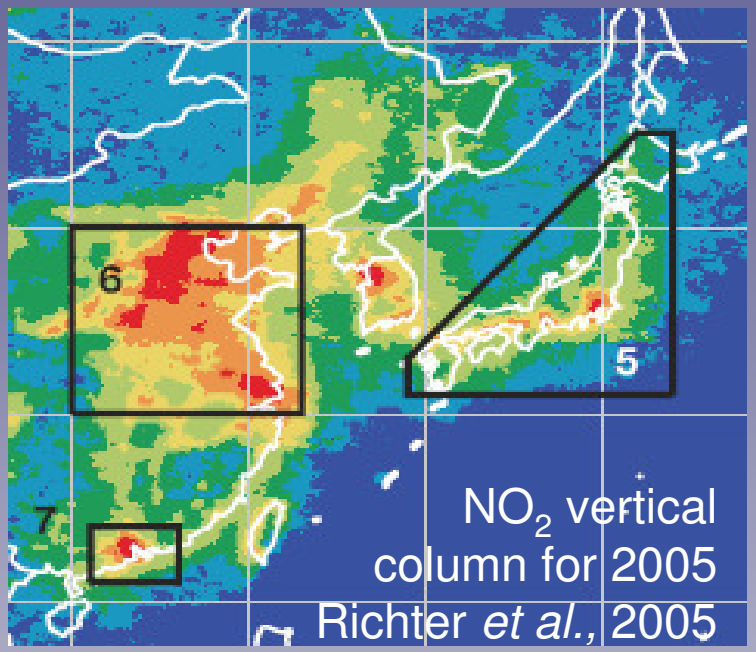
Crosscutting Theme:
Greenhouse Gas Initiative (GGI)

The objective is to bridge temporal and spatial scales of climate change, from shorter-term national and place-specific policies and measures directed at mitigating and adapting to climate change, to the longer-term global objective of stabilizing atmospheric concentrations of greenhouse gases at a "non-dangerous" level

Sustainable Development is a Guiding Star for the Work

Air Pollutants

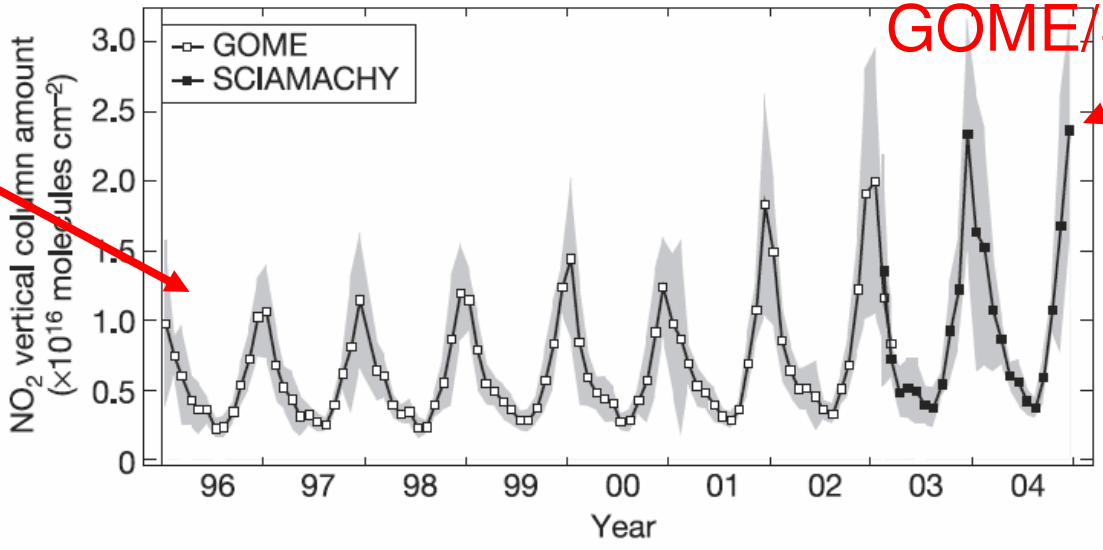




Red = more

Green = less

RAINS
1995



GOME/SCIAMACHY
2005

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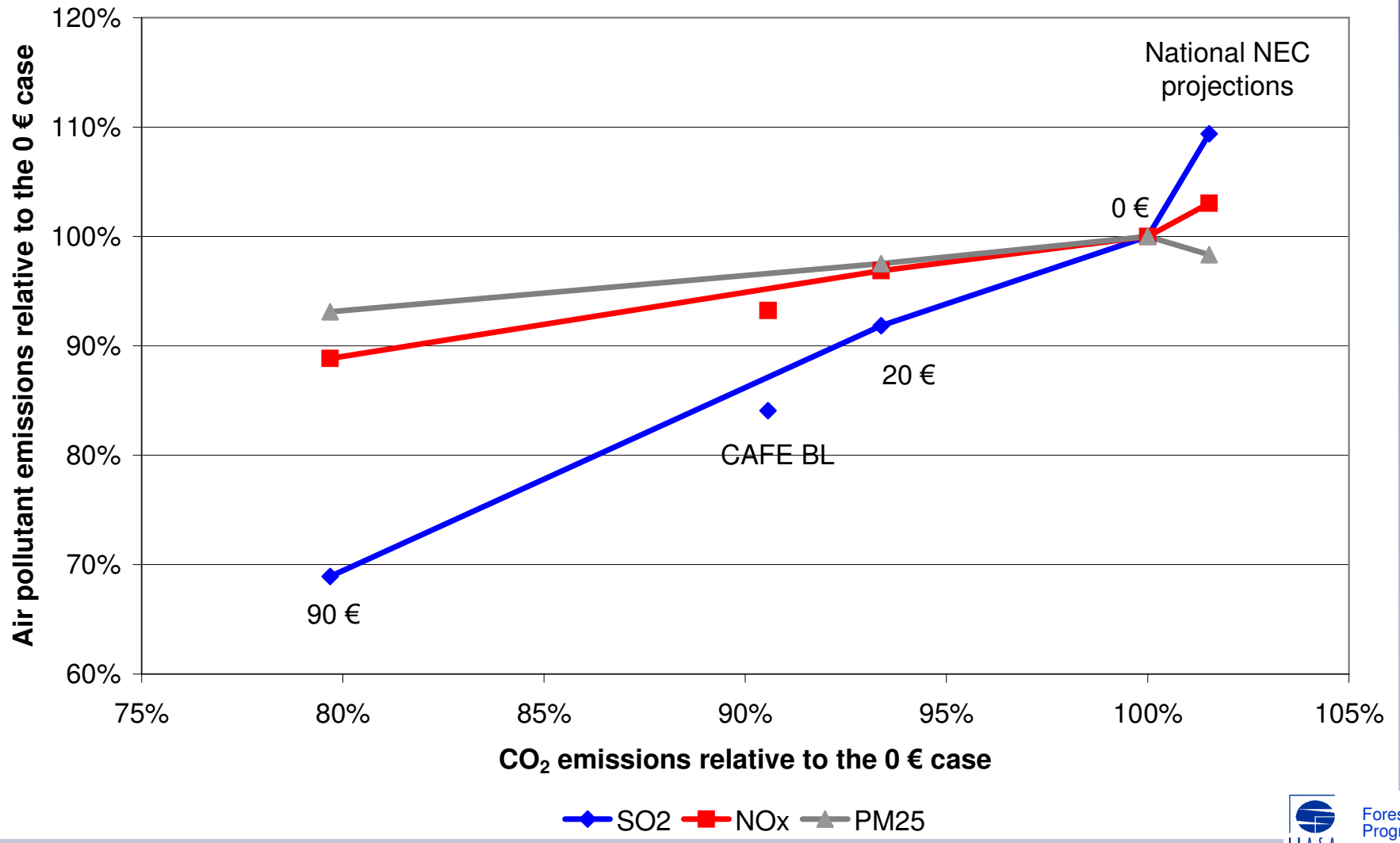
Air Pollutant Emissions

as a function of CO_2 mitigation (EU-25, 2020)



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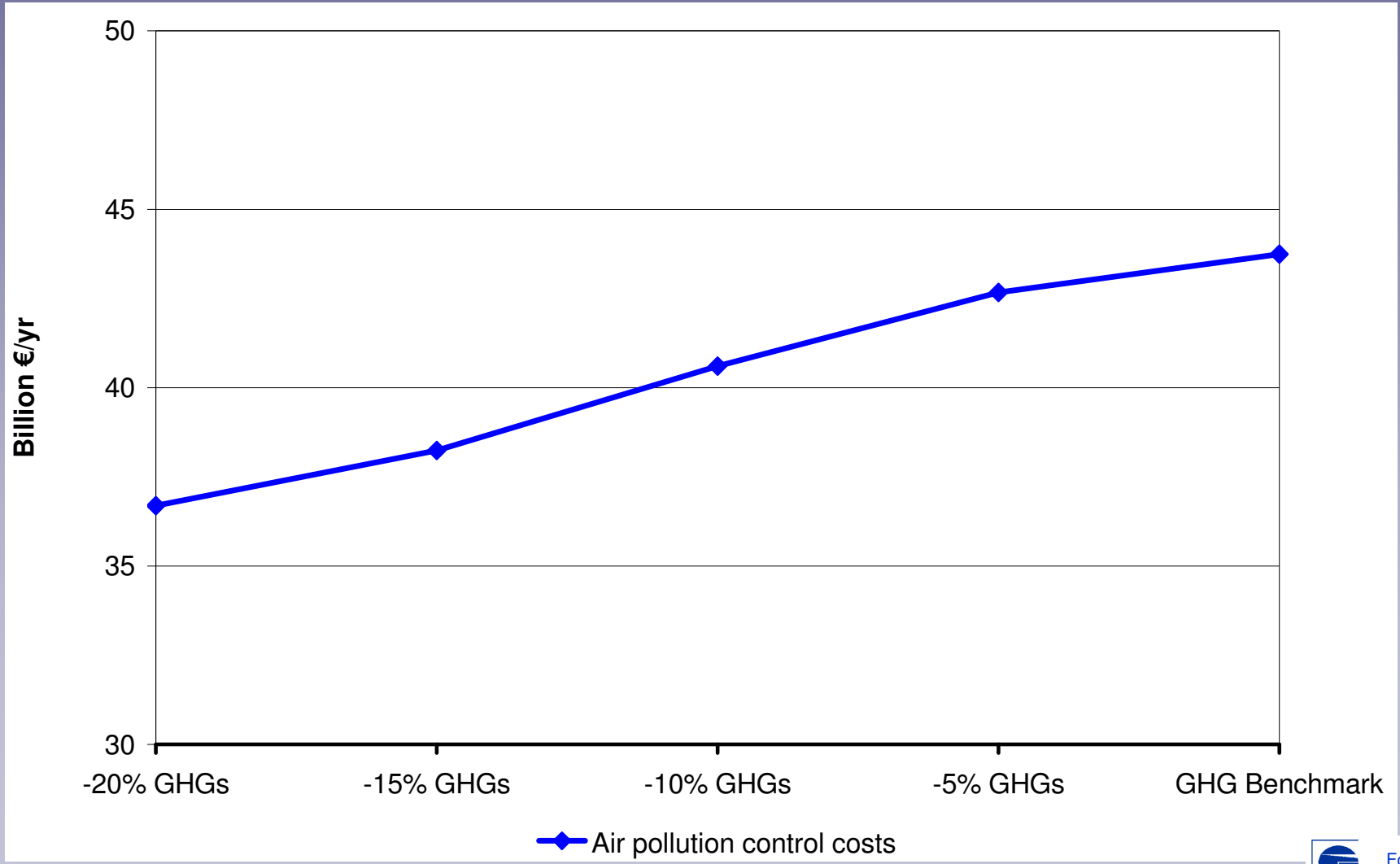
Air Pollution Control Costs for Current Legislation 2020

(SO_2, NO_x, PM) as a function of CO_2 mitigation (EU-25, 2020)



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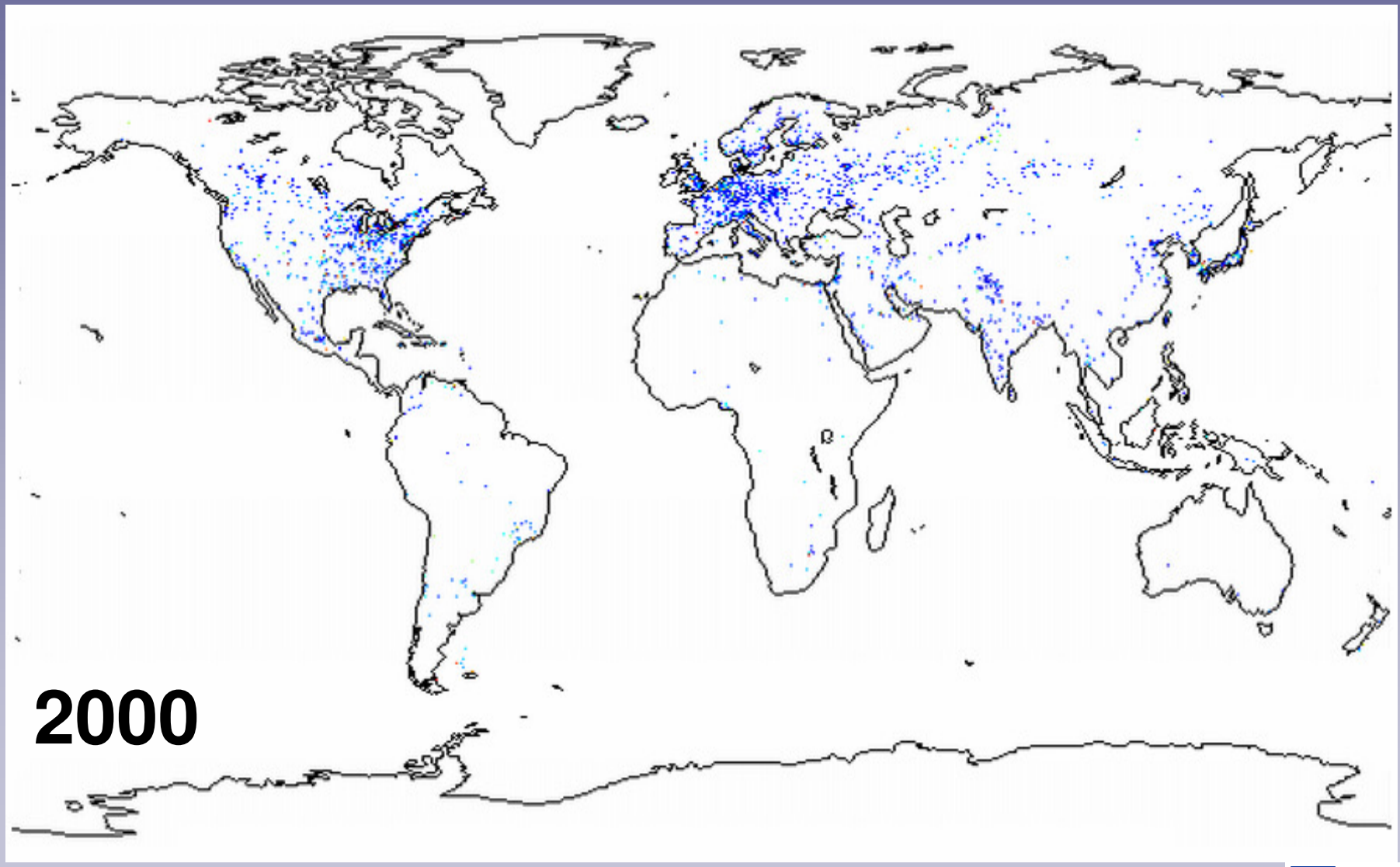
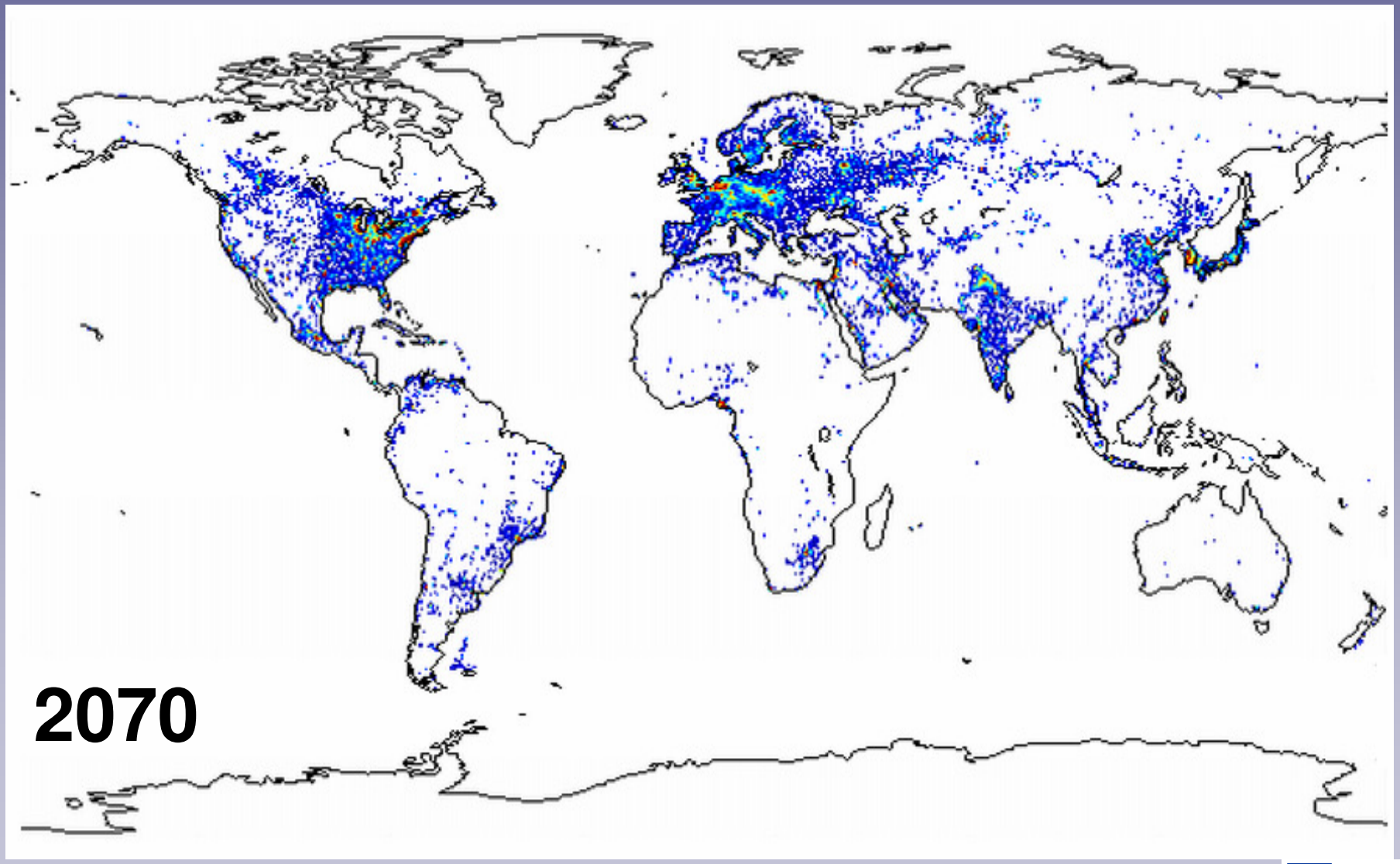
Night Lights



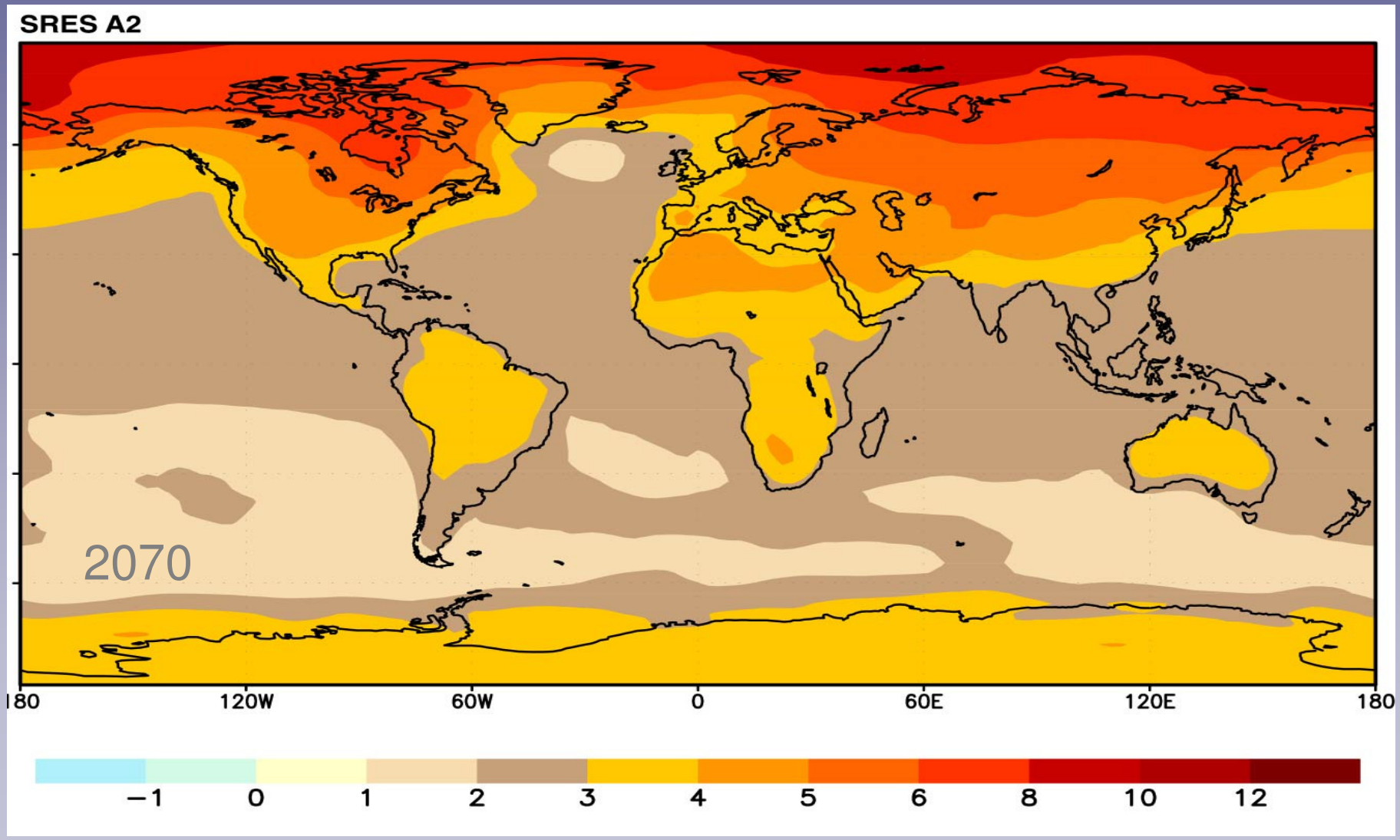
Source: Nakicenovic 2006

Night Lights



Source: Nakicenovic 2006

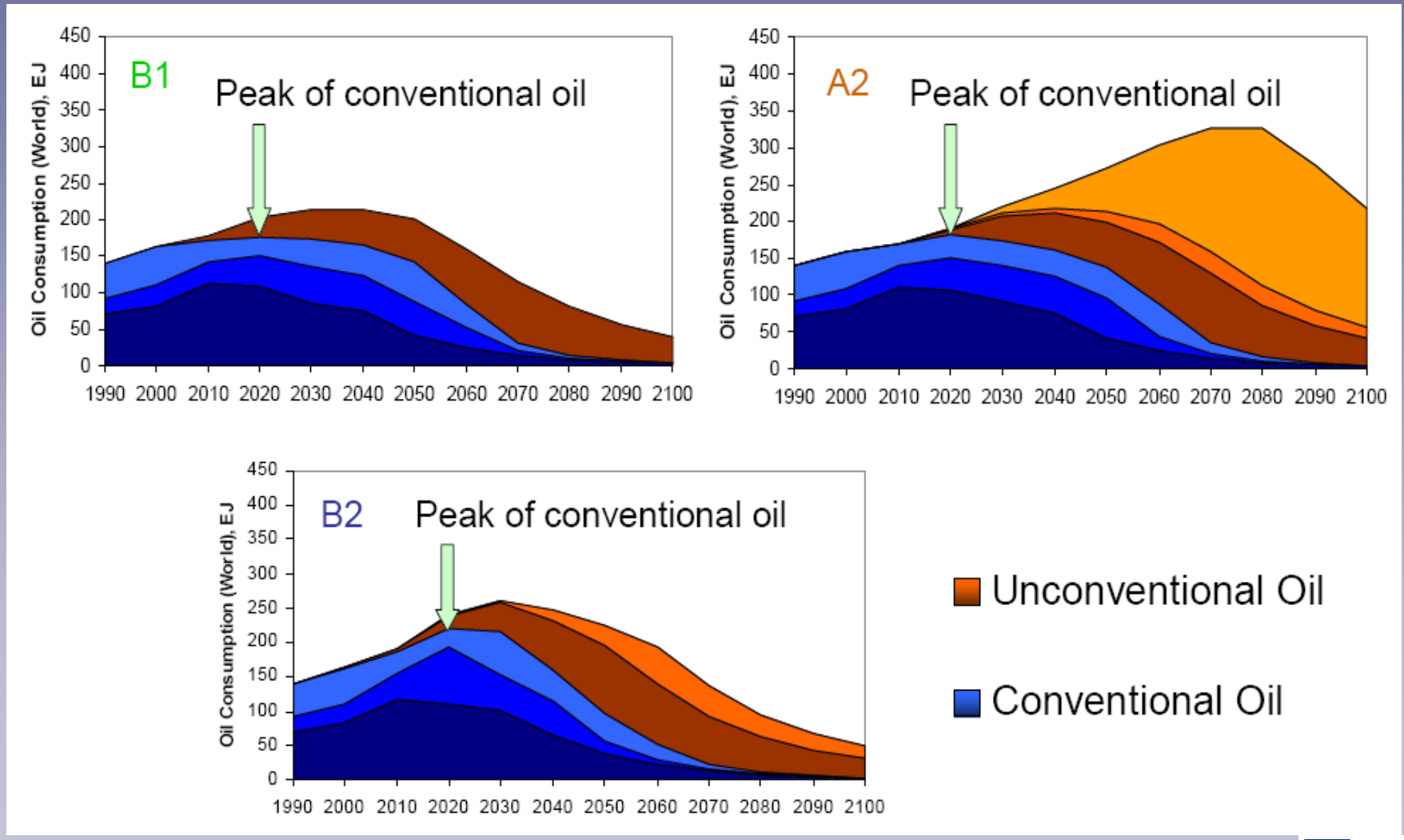
Δ Temperature



Source: Nakicenovic 2006

Energy Development

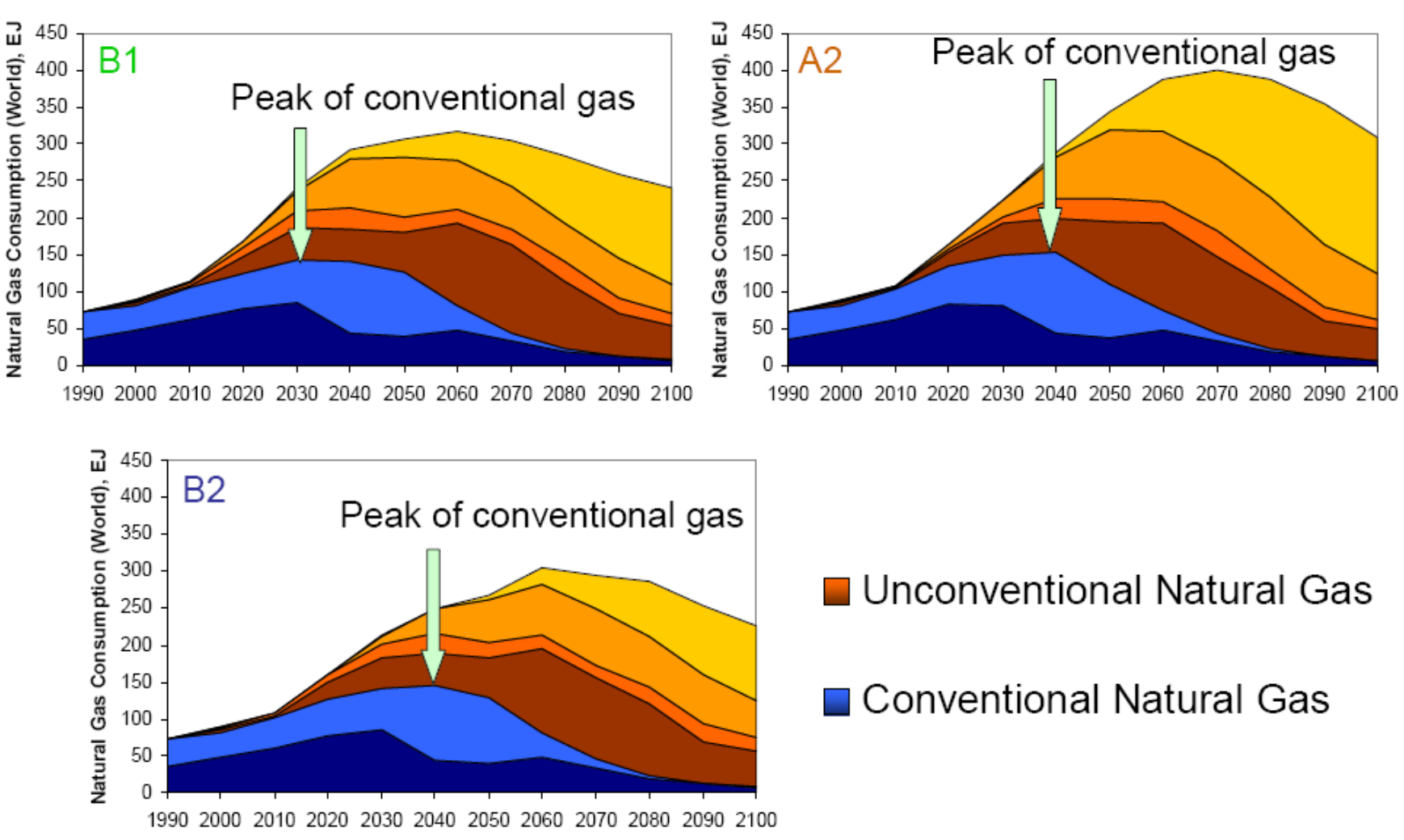
Global Oil Consumption (conventional/unconventional reserves and resources)



Source: Riahi and Keppo (2006)

Energy Development

Global Natural Gas Consumption (conventional/unconventional reserves and resources)

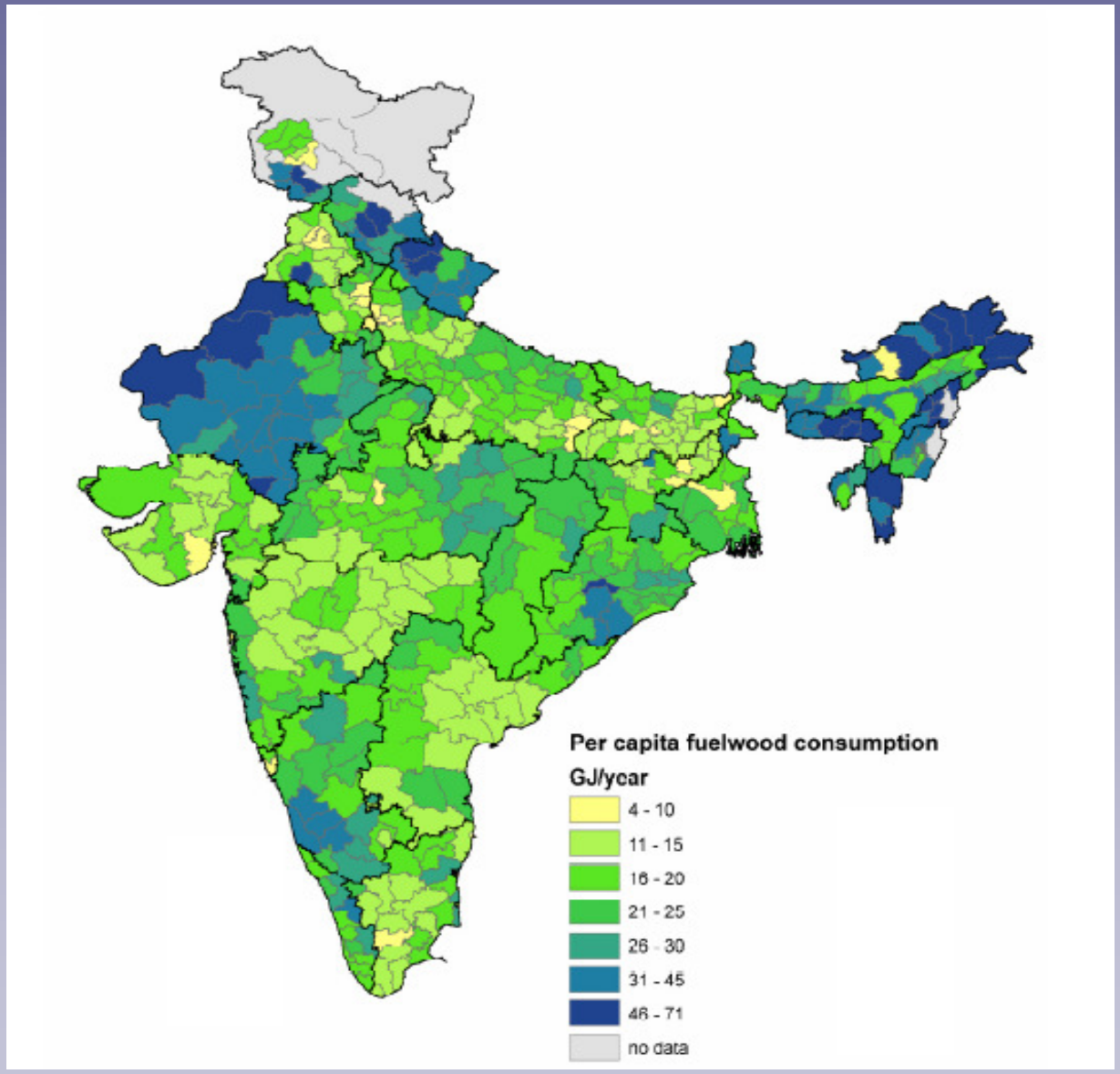


Source: Riahi and Keppo (2006)

Population and Climate Change Program

- Assess energy use and economic activities across different types of households
- Assess the associated emissions
- Scenarios on energy/economic/emission developments

Biomass Consumption Map



Source: Household Consumer Expenditure Survey, Roujnd55. National Sample Survey Organisation

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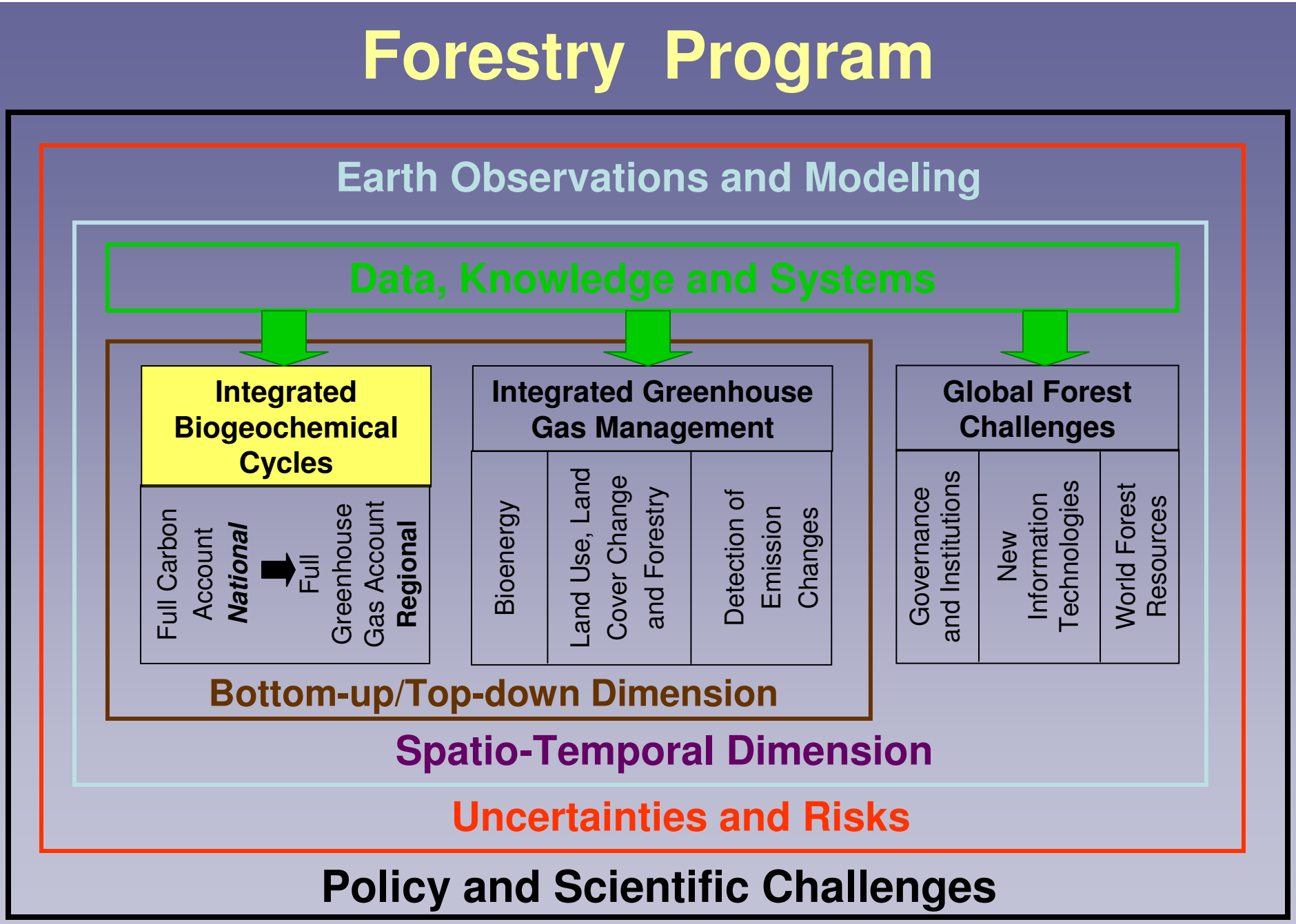
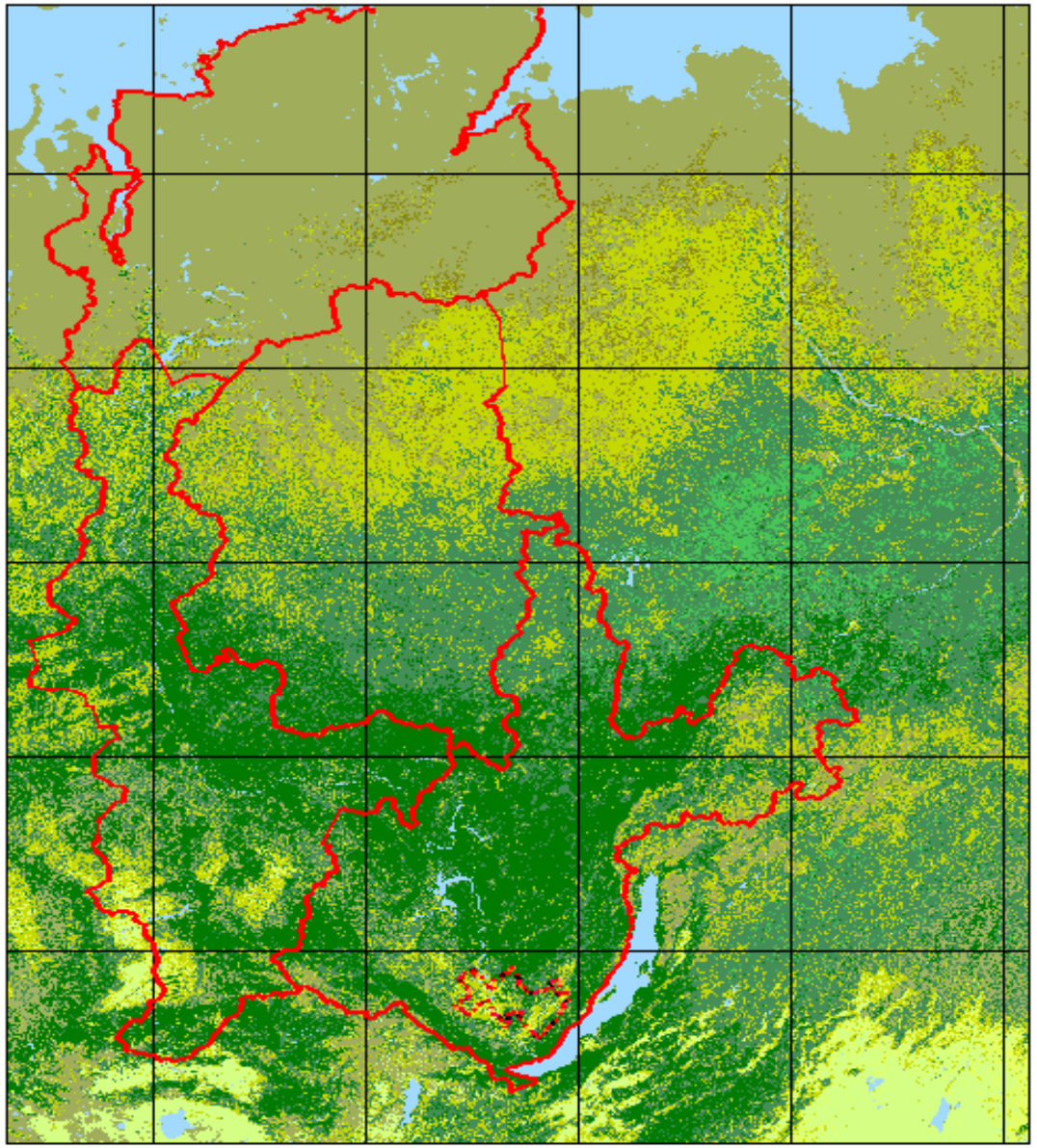
Forestry Program



Passive Optical Sensors		NOAA AVHRR
		ENVISAT AATSR
		ENVISAT MERIS
		TERRA MISR
		ERS ATSR-2
		TERRA MODIS
		TERRA ASTER
		Landsat TM 5
		Landsat ETM
		SPOT Vegetation
		DMSP OLS
		DMSP SSM/I
		Resurs-01 (MSU-SK)
Active Optical Sensors (Laser)		None; although interest in Vegetation Canopy Lidar (VCL) Mission
Active Microwave Sensors	SAR	ENVISAT ASAR
		ERS-2 SAR
		ERS-1 SAR
		JERS-1 (historical data)
	Scatterometer	QuikScat SeaWinds
		ERS AMI-SCAT
Passive Microwave Sensors		(SMMR, ADEOS-II AMSR)

Multi-sensor Remote Sensing Concept



SIBERIA-II LC map using c4.5 classifier (UMD classes)

(MODIS 2001)

- Evergreen Needle
- Evergreen Broadleaf
- Deciduos Needleleaf
- Deciduos Broadleaf
- Mixed Forest
- Woodland
- Wooded Grassland
- Closed Shrubland
- Open Shrubland
- Grassland
- Cropland
- Bare Ground
- Urban
- Water

University of Wales Swansea

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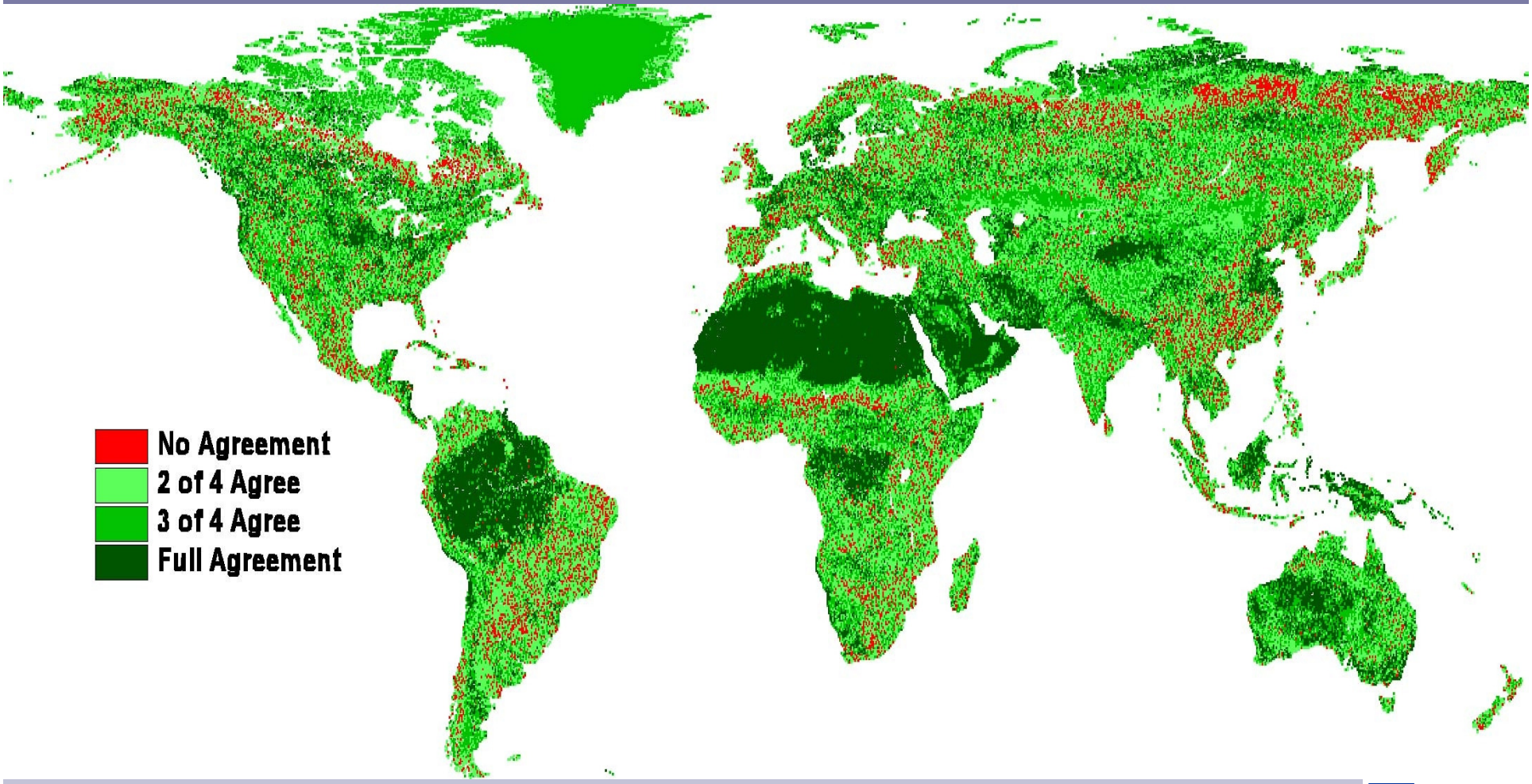
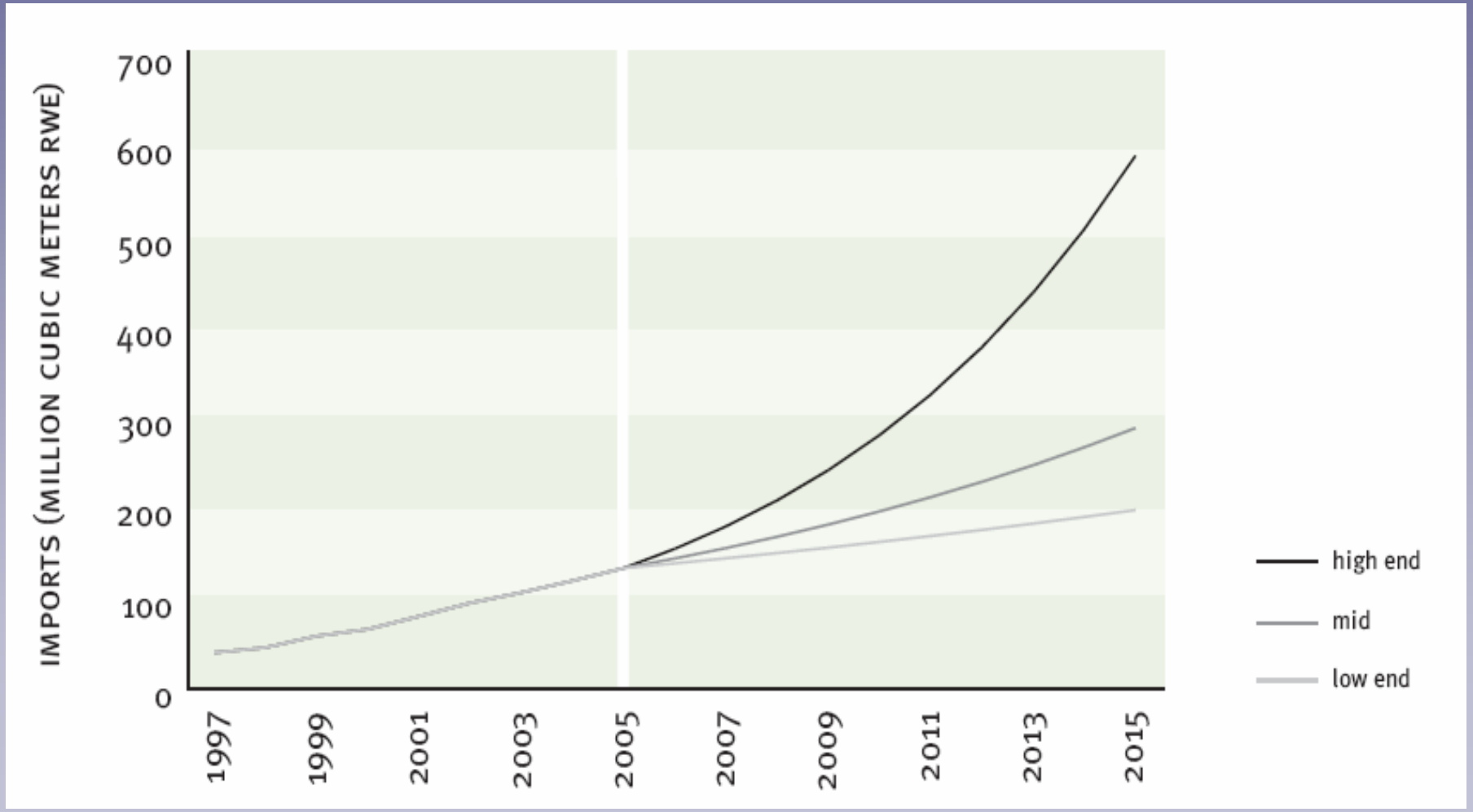
Four Global Land Cover Sets

The global level of agreement among the four datasets using complete IGBP classification



Chinese Imports of Forest Products: Actual and Potential Trends (1997–2015)



Source: Chinese customs statistics and FT projections

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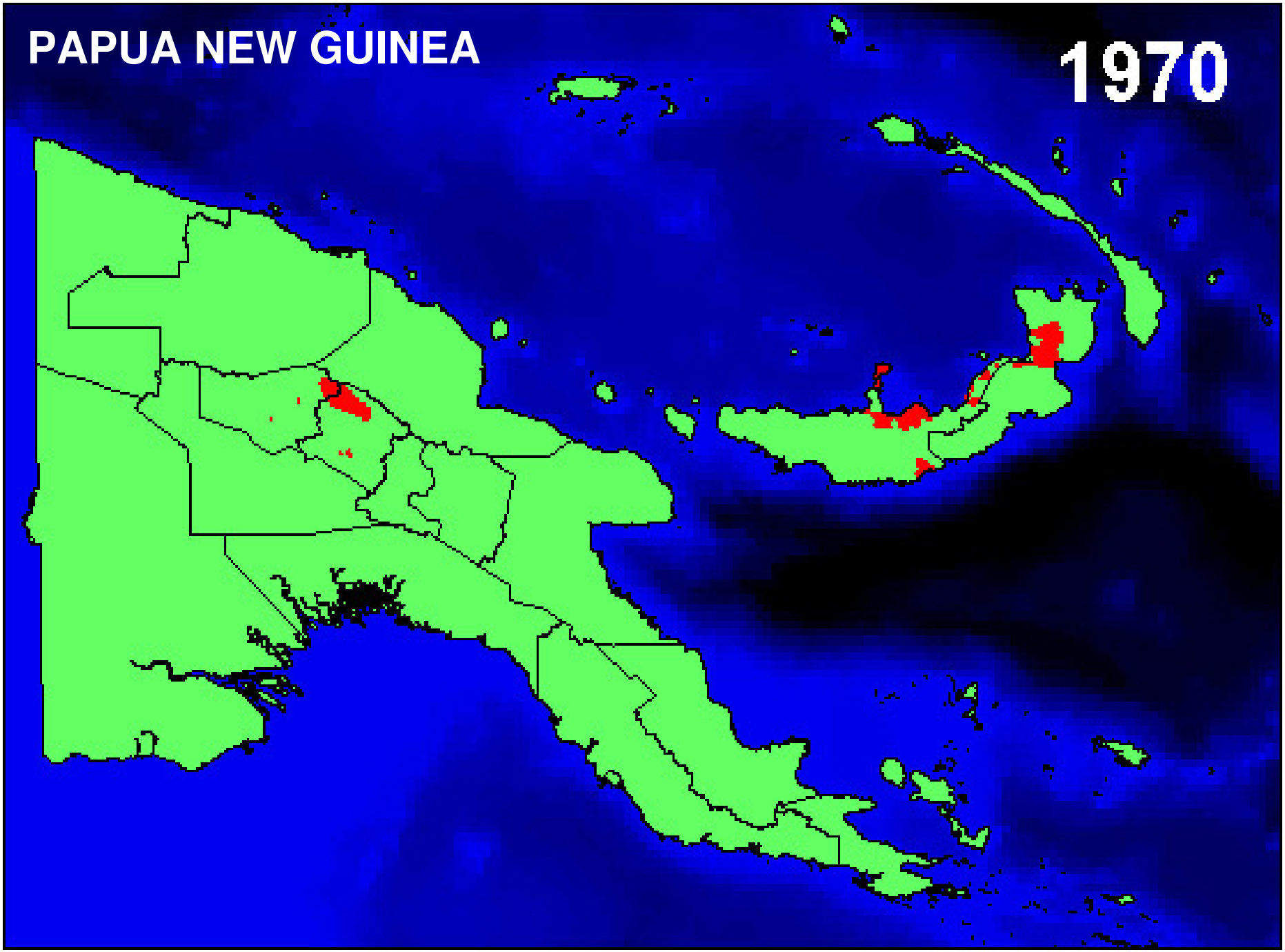
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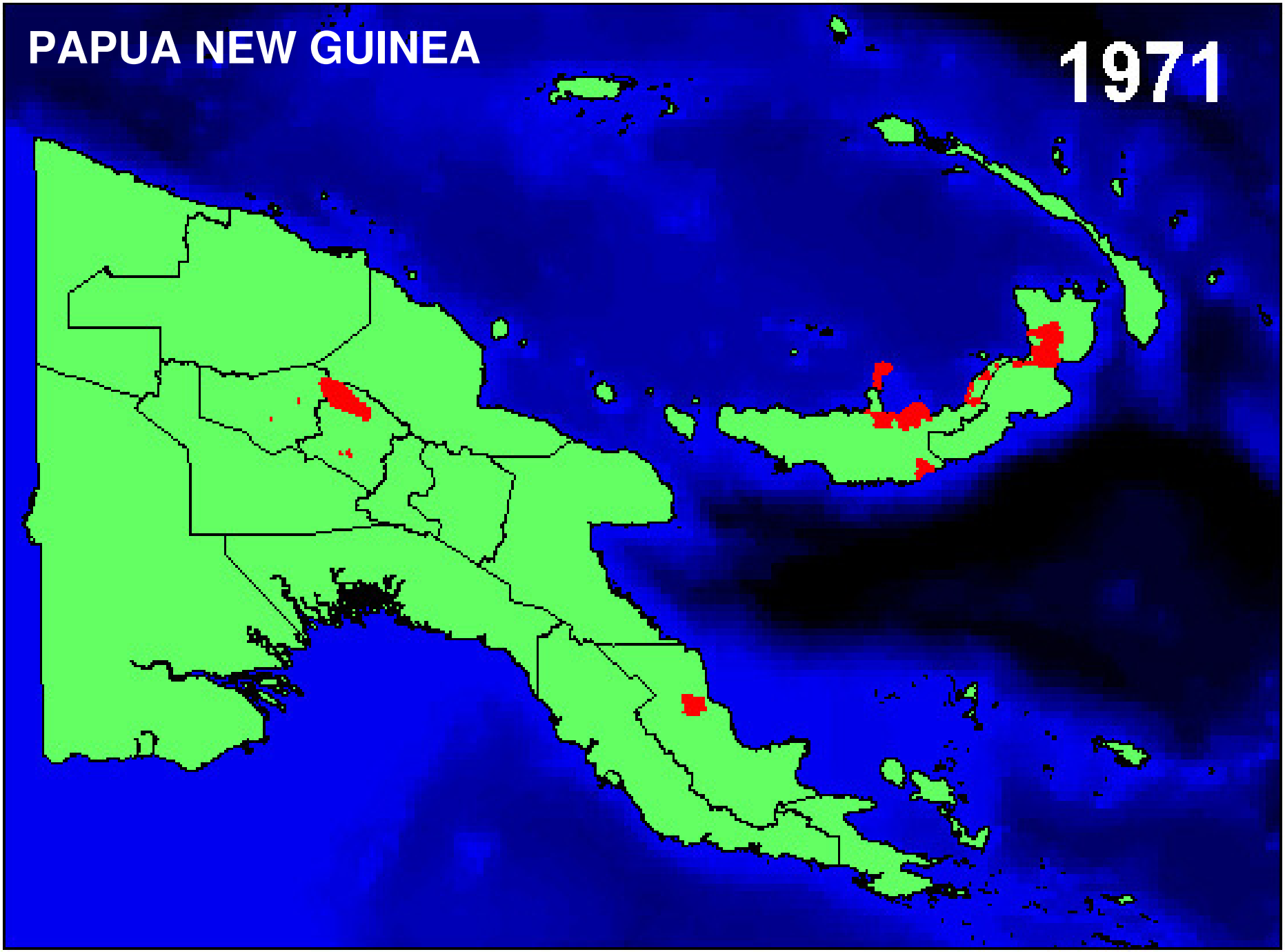
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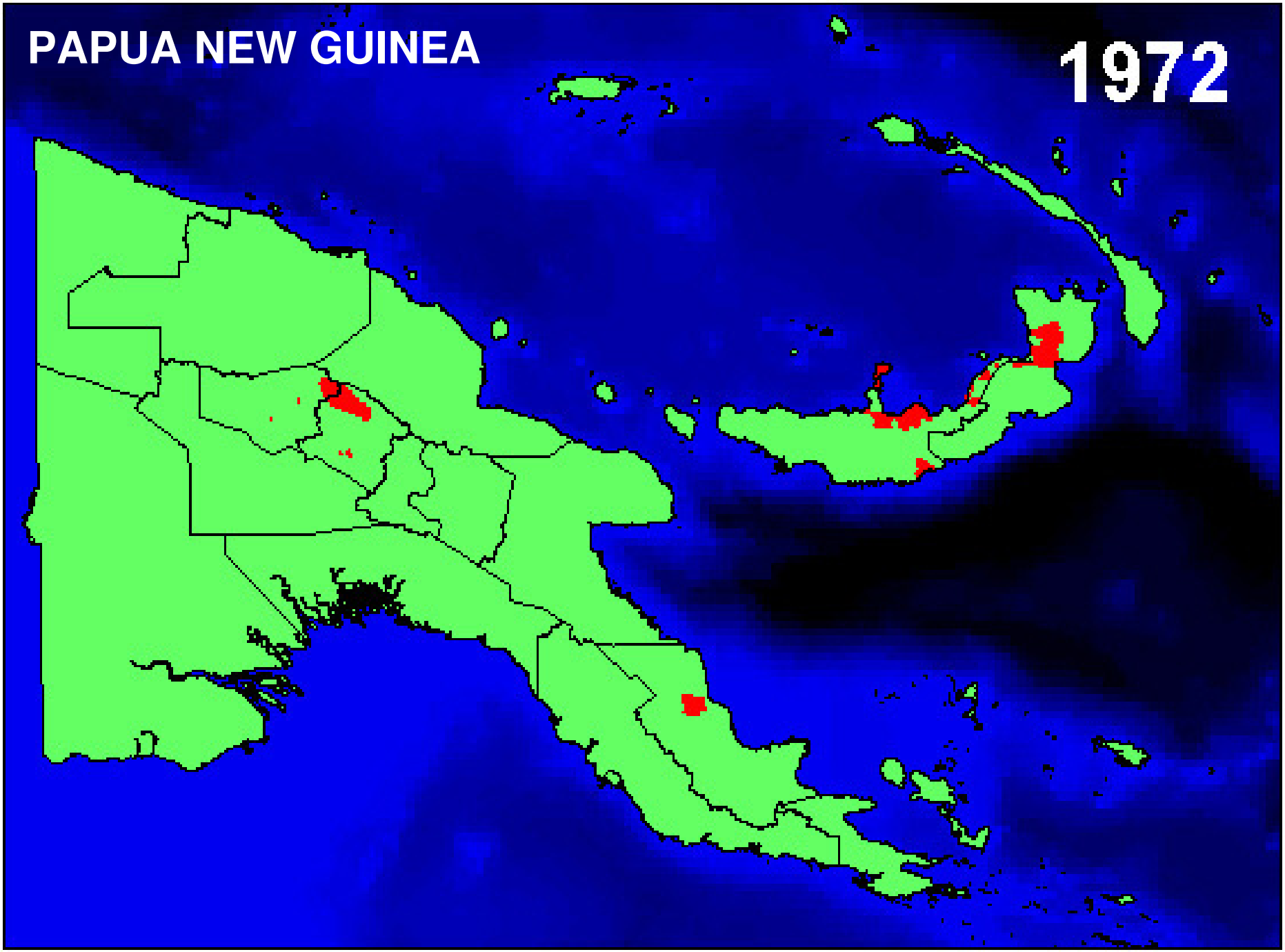
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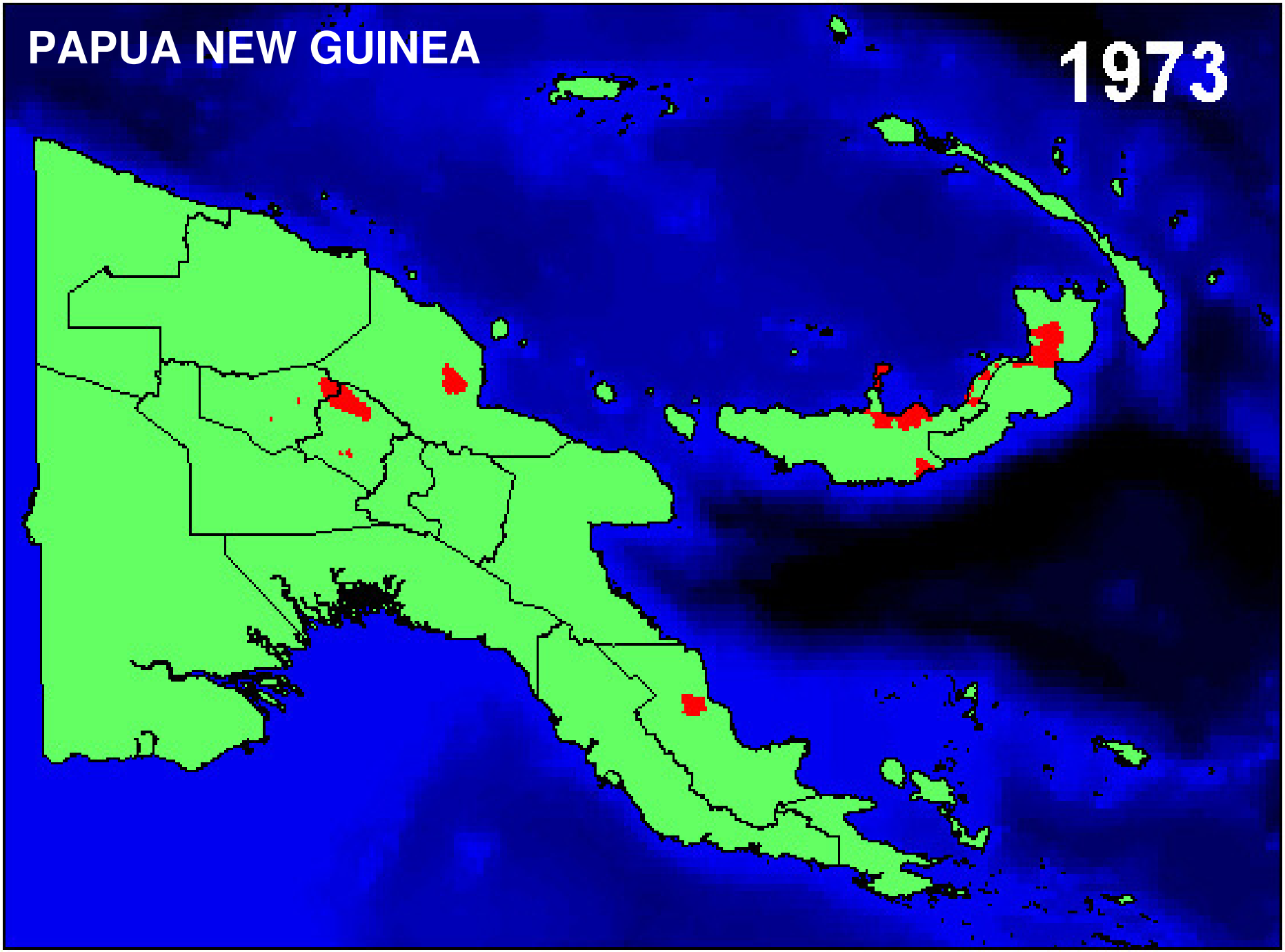
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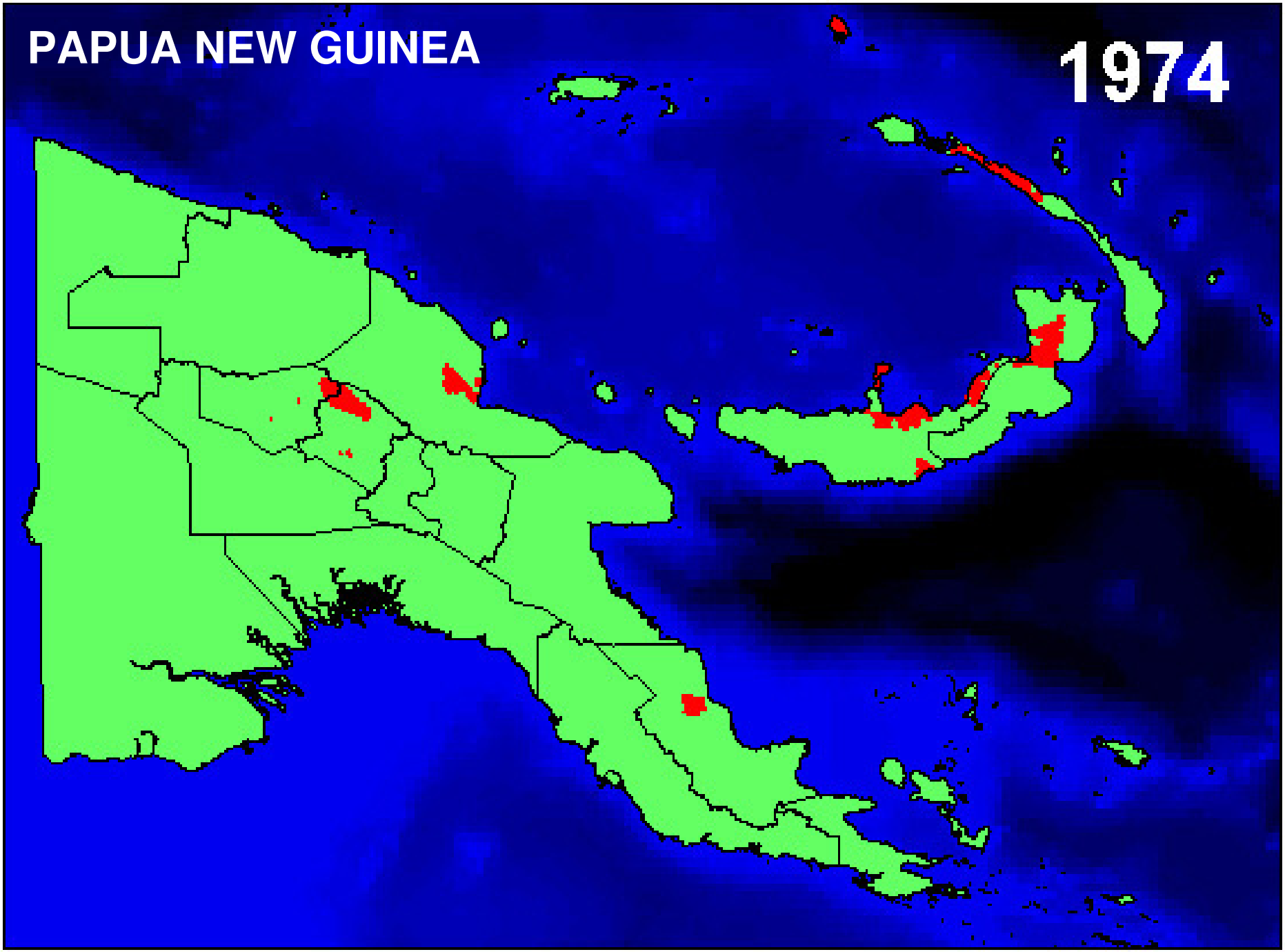
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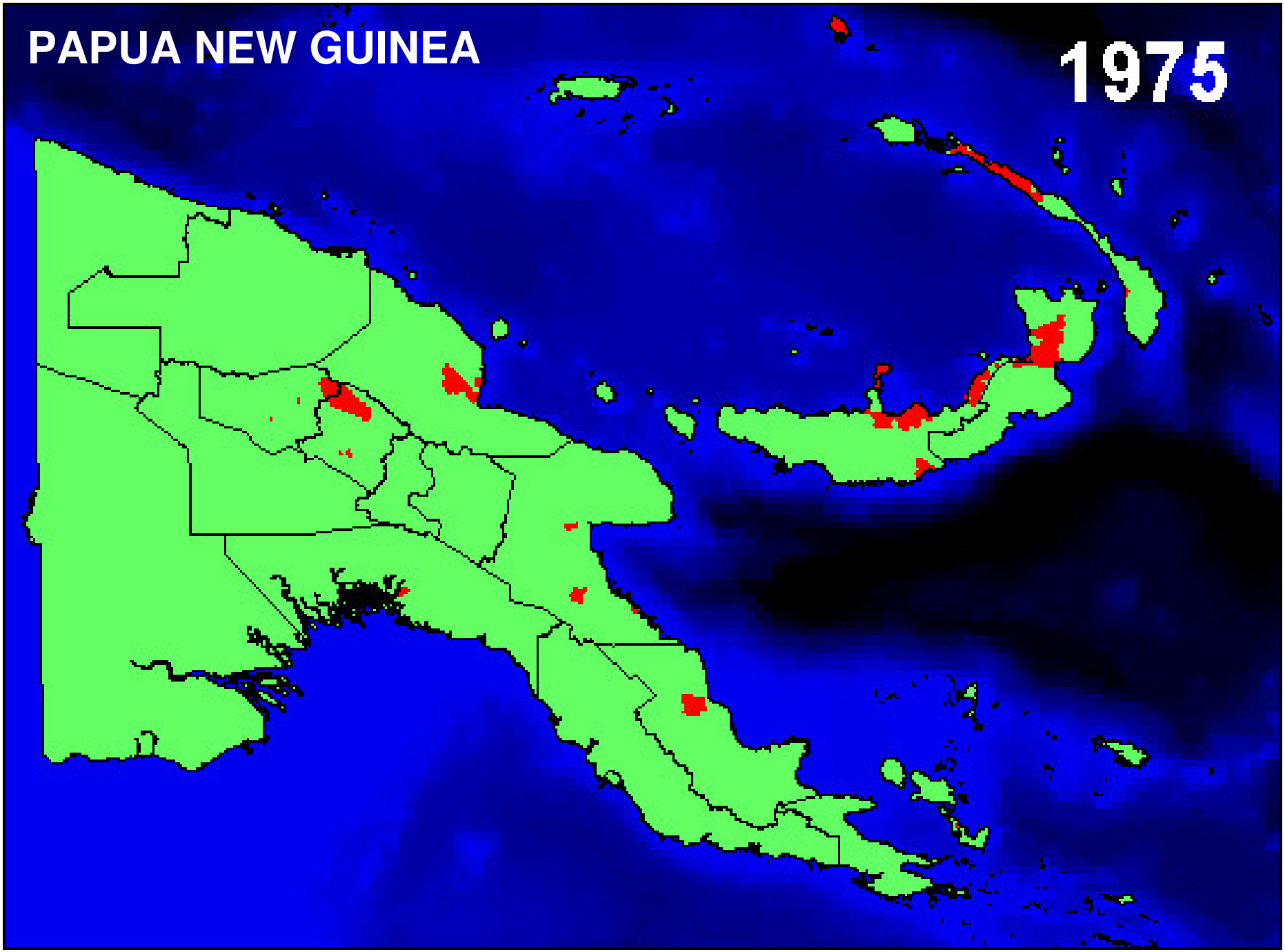
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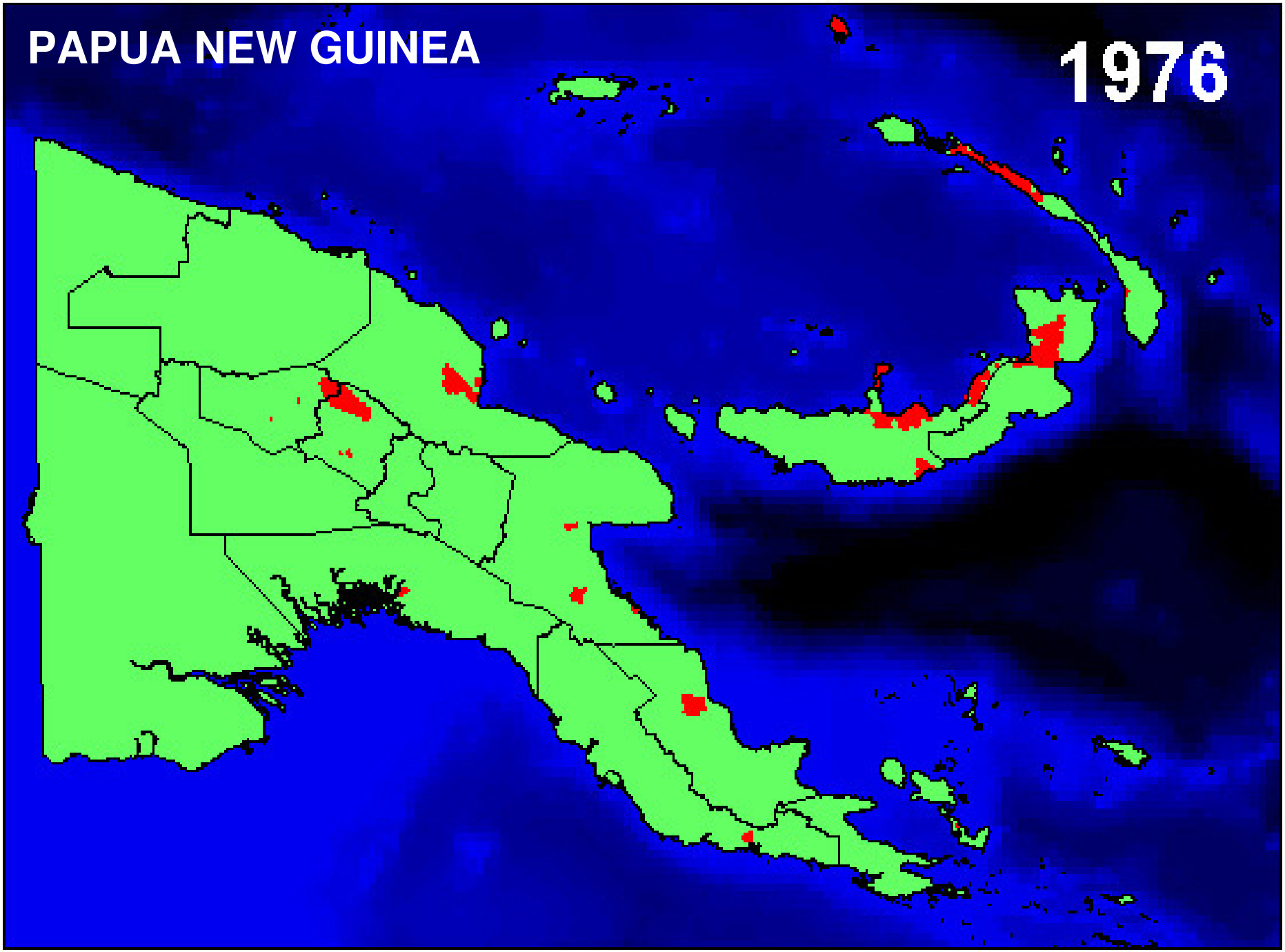
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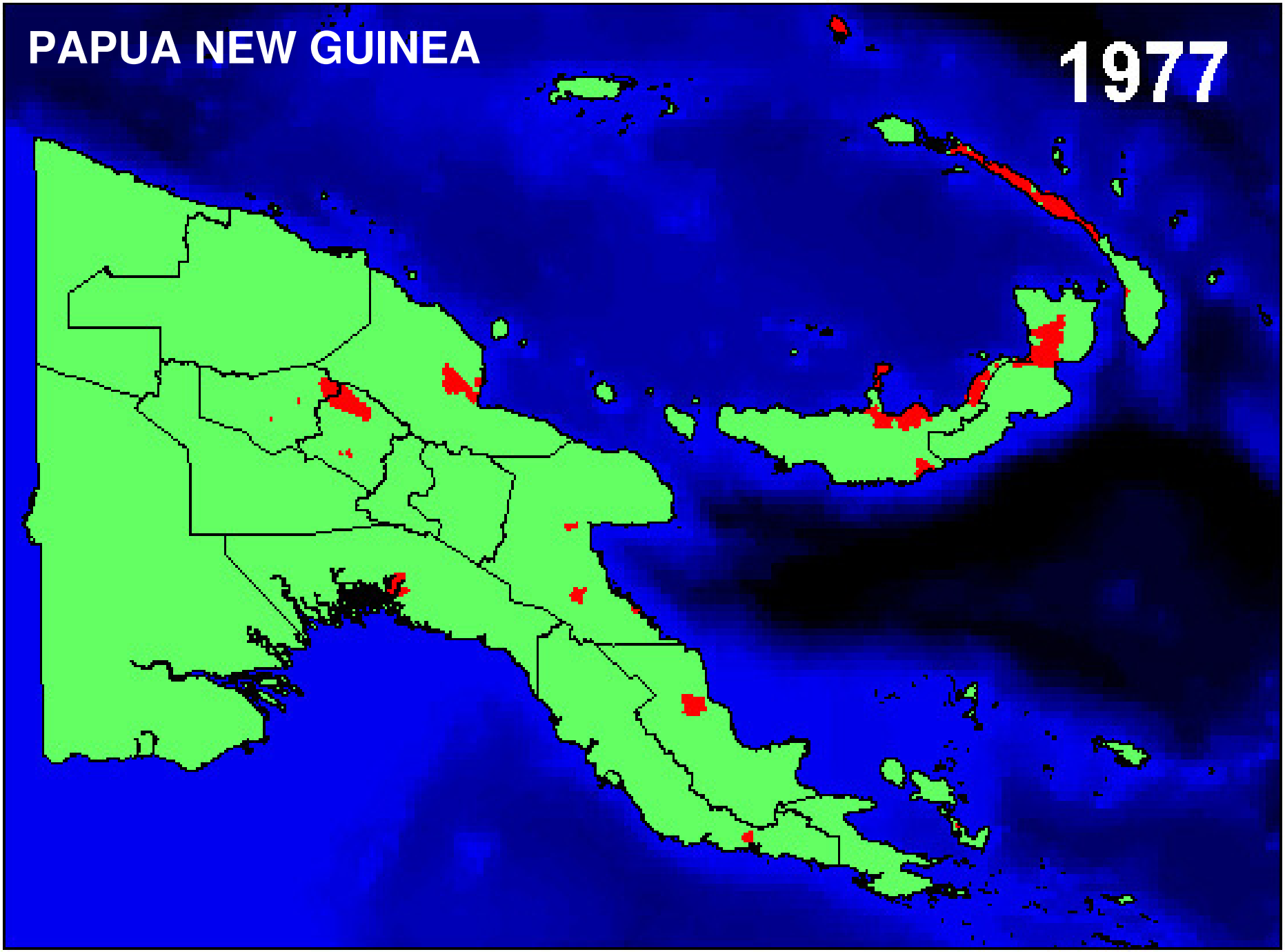
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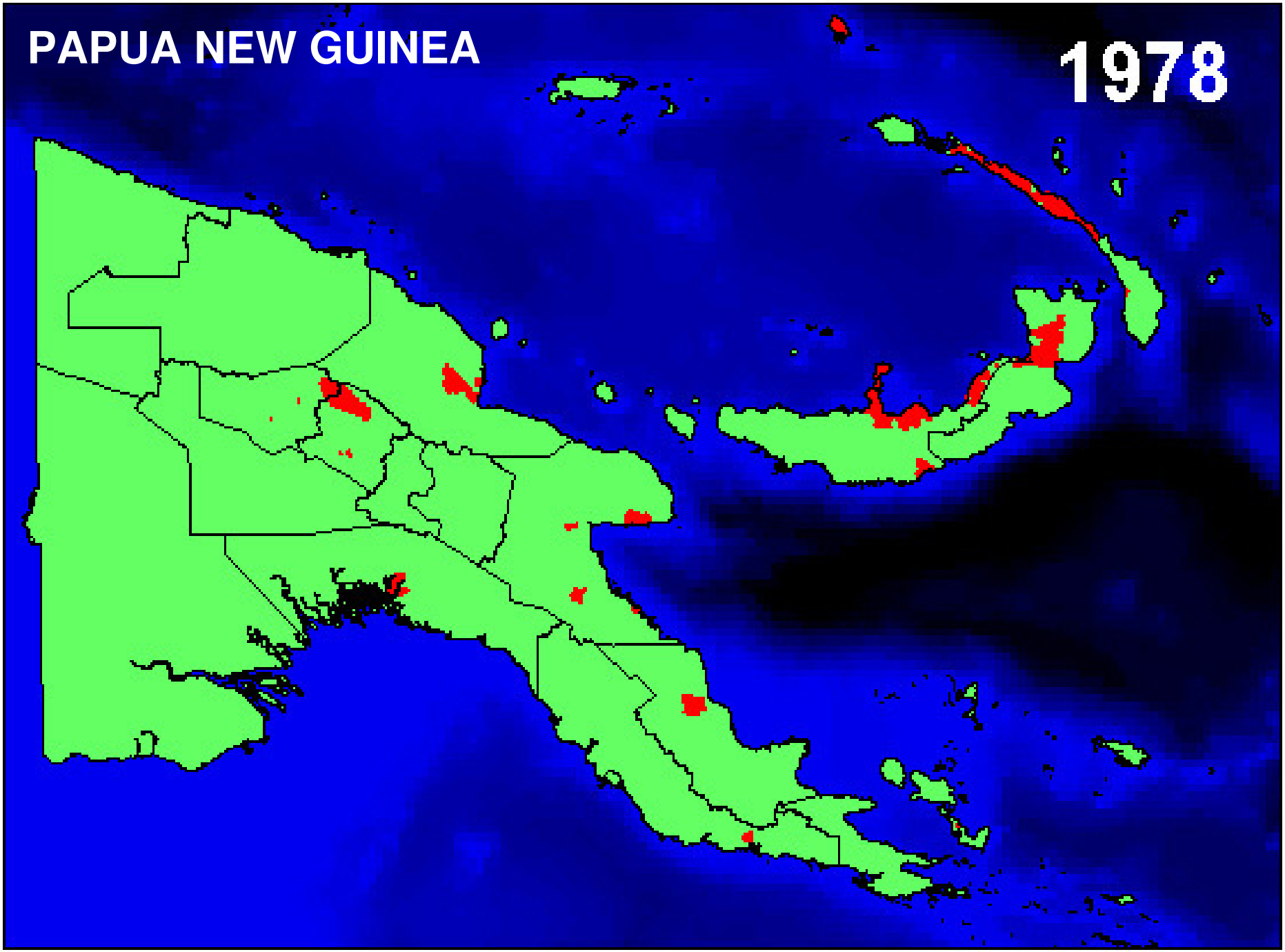
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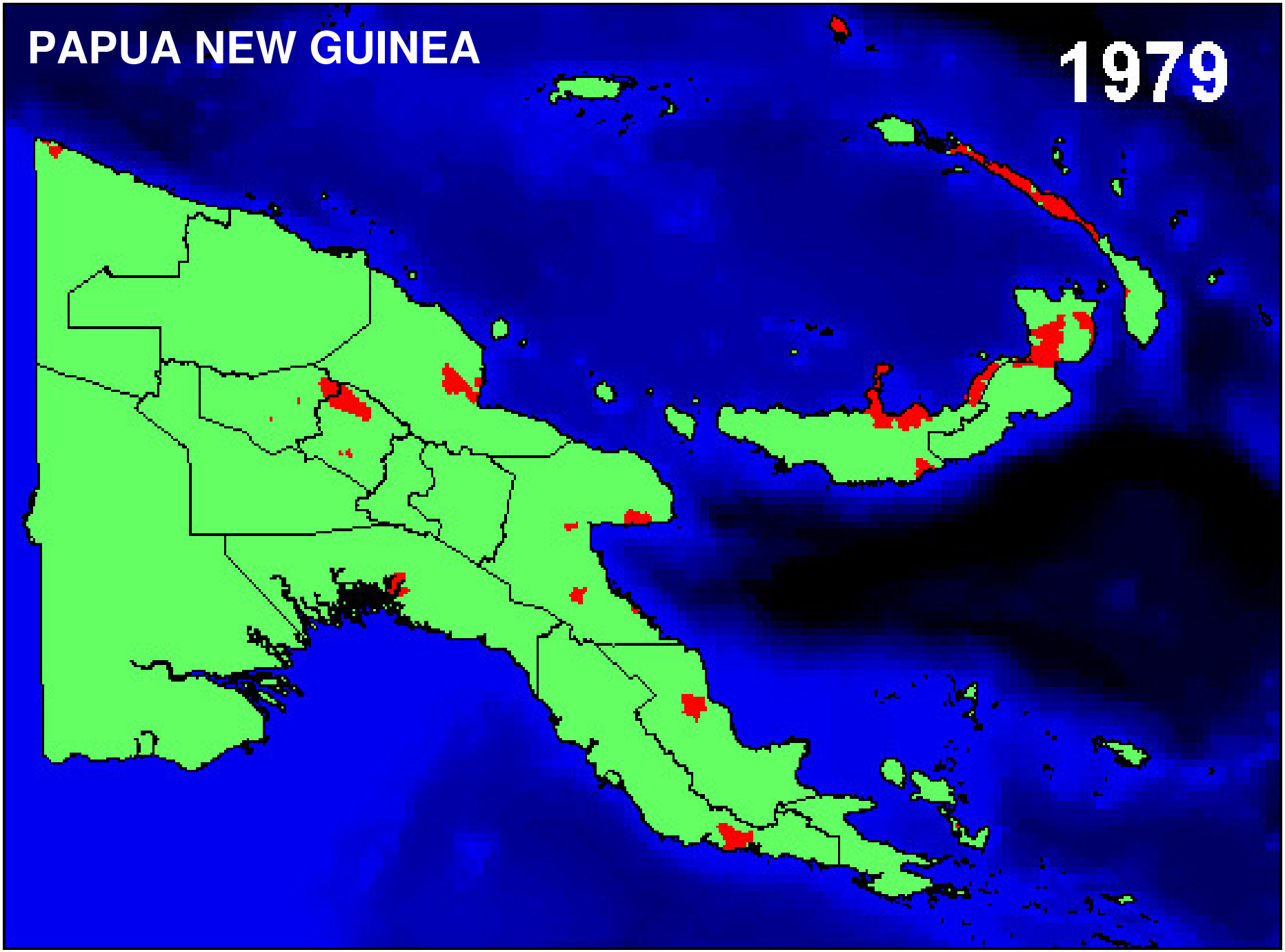
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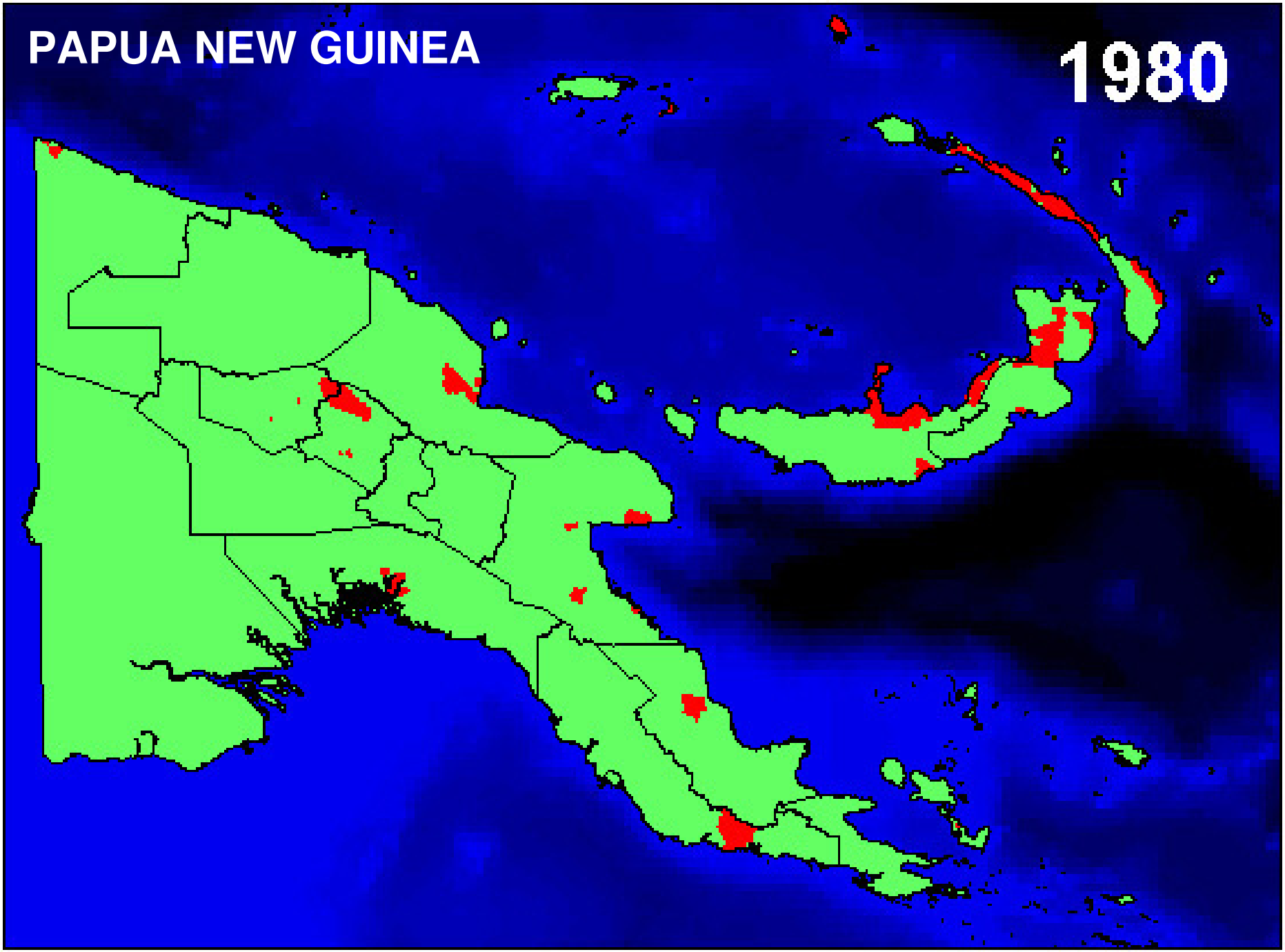
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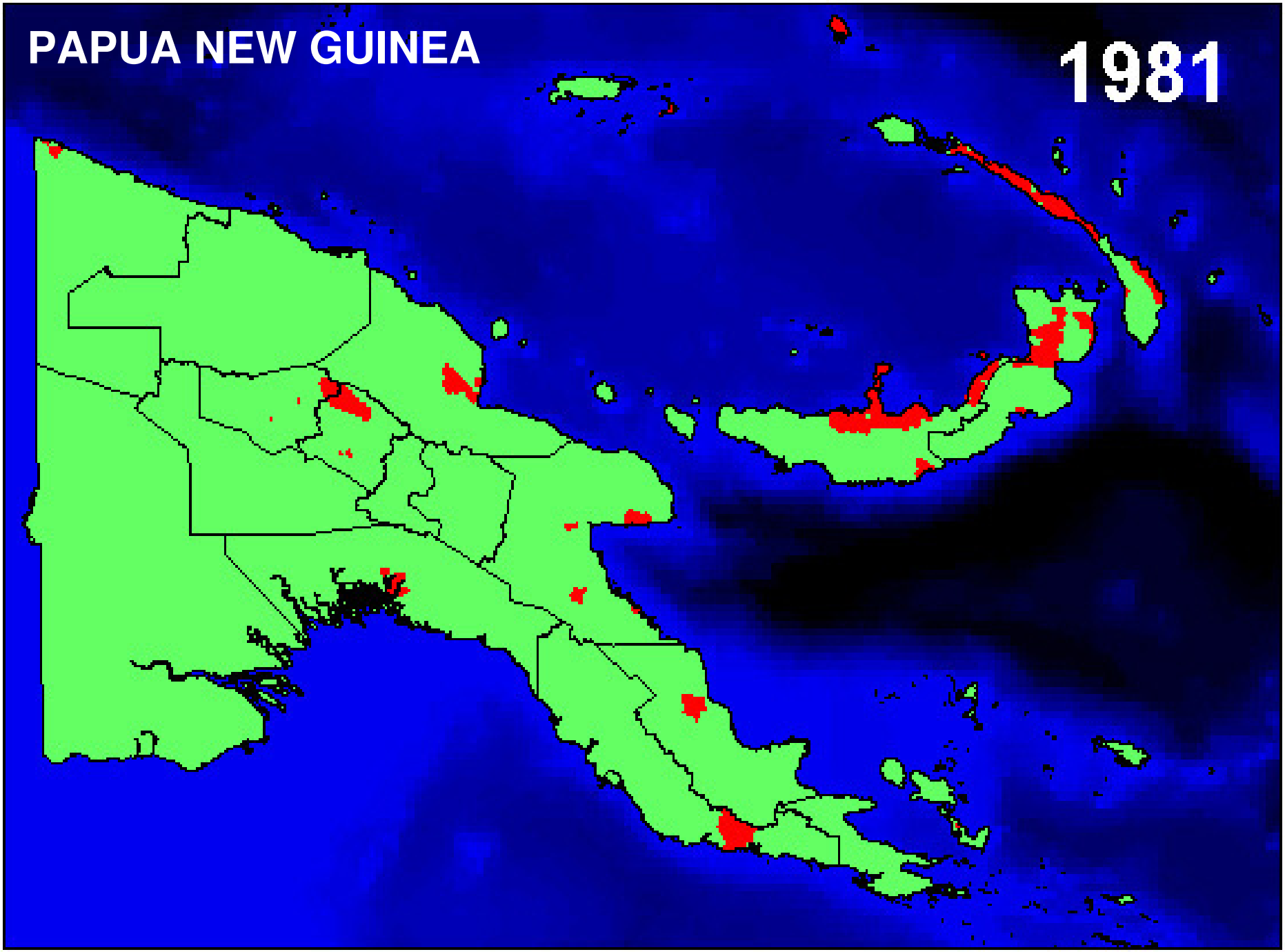
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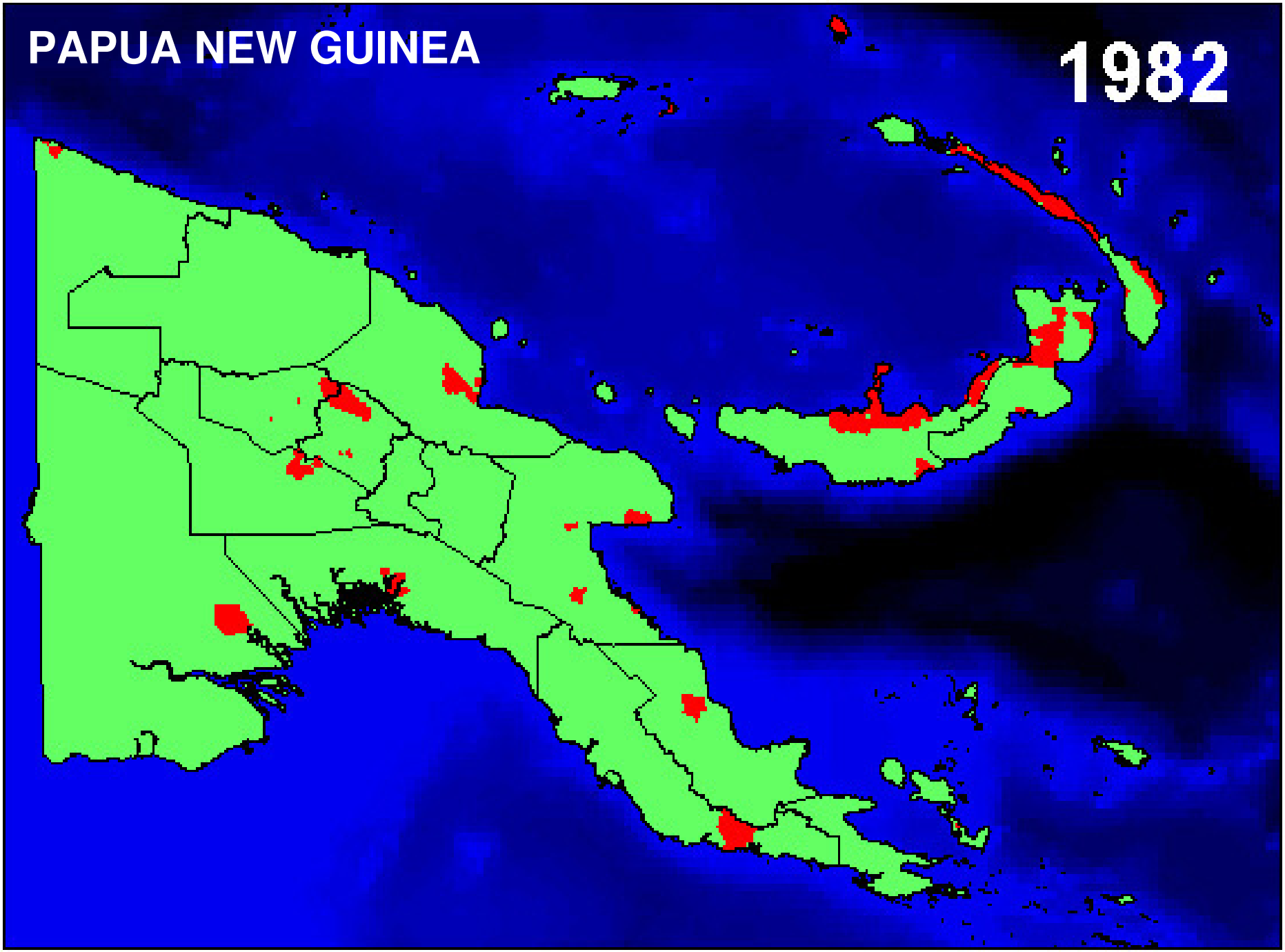
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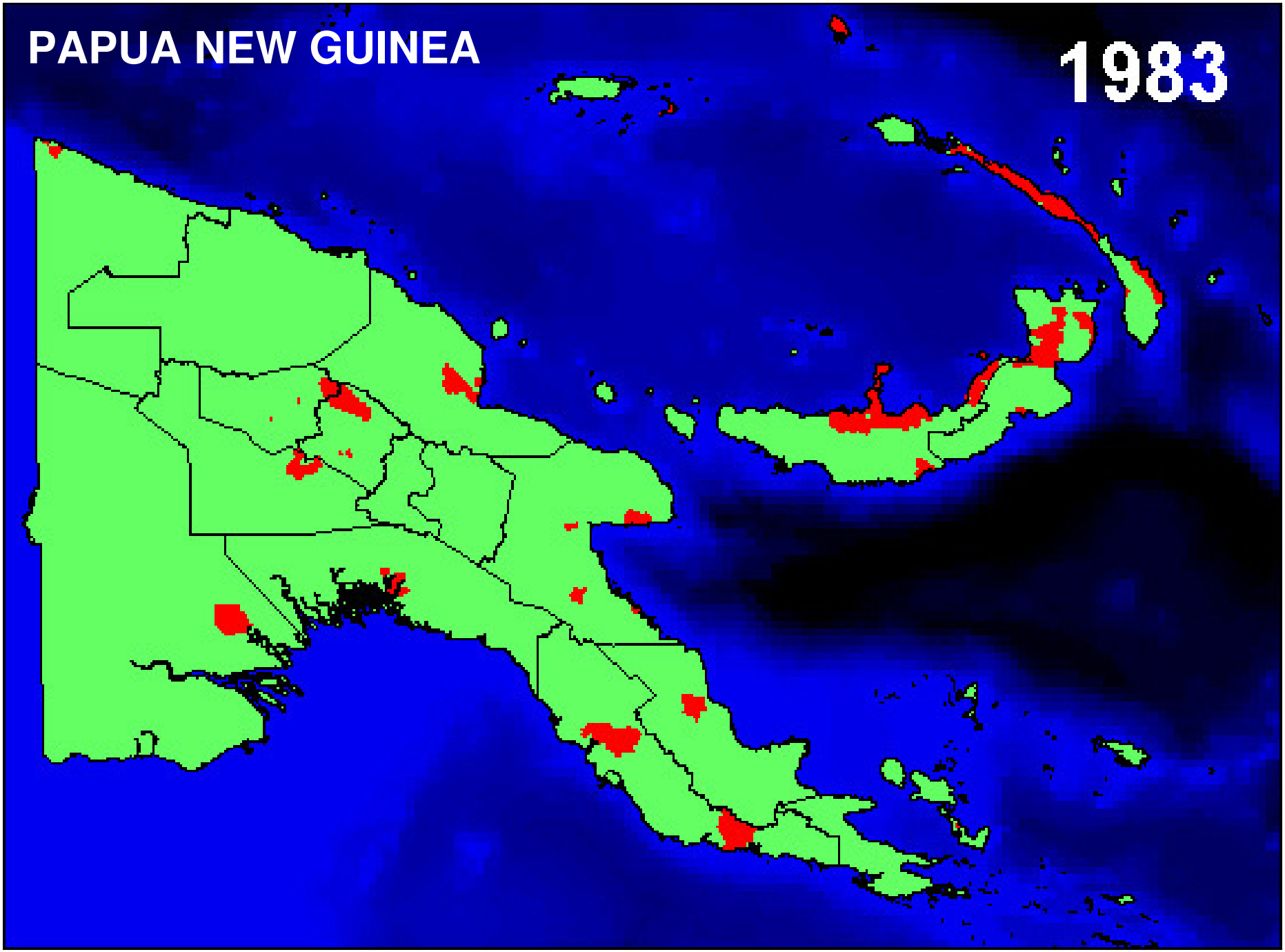
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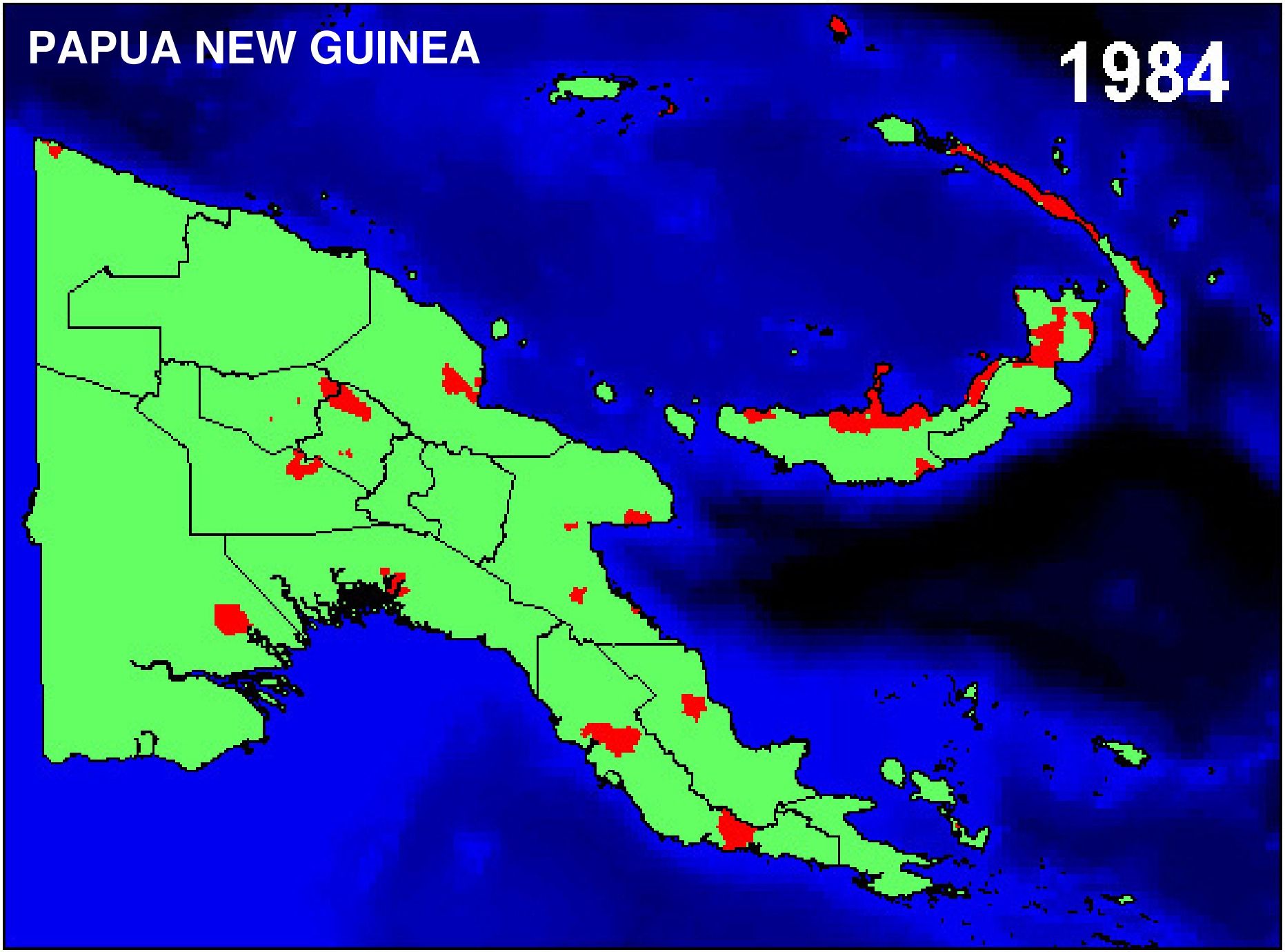
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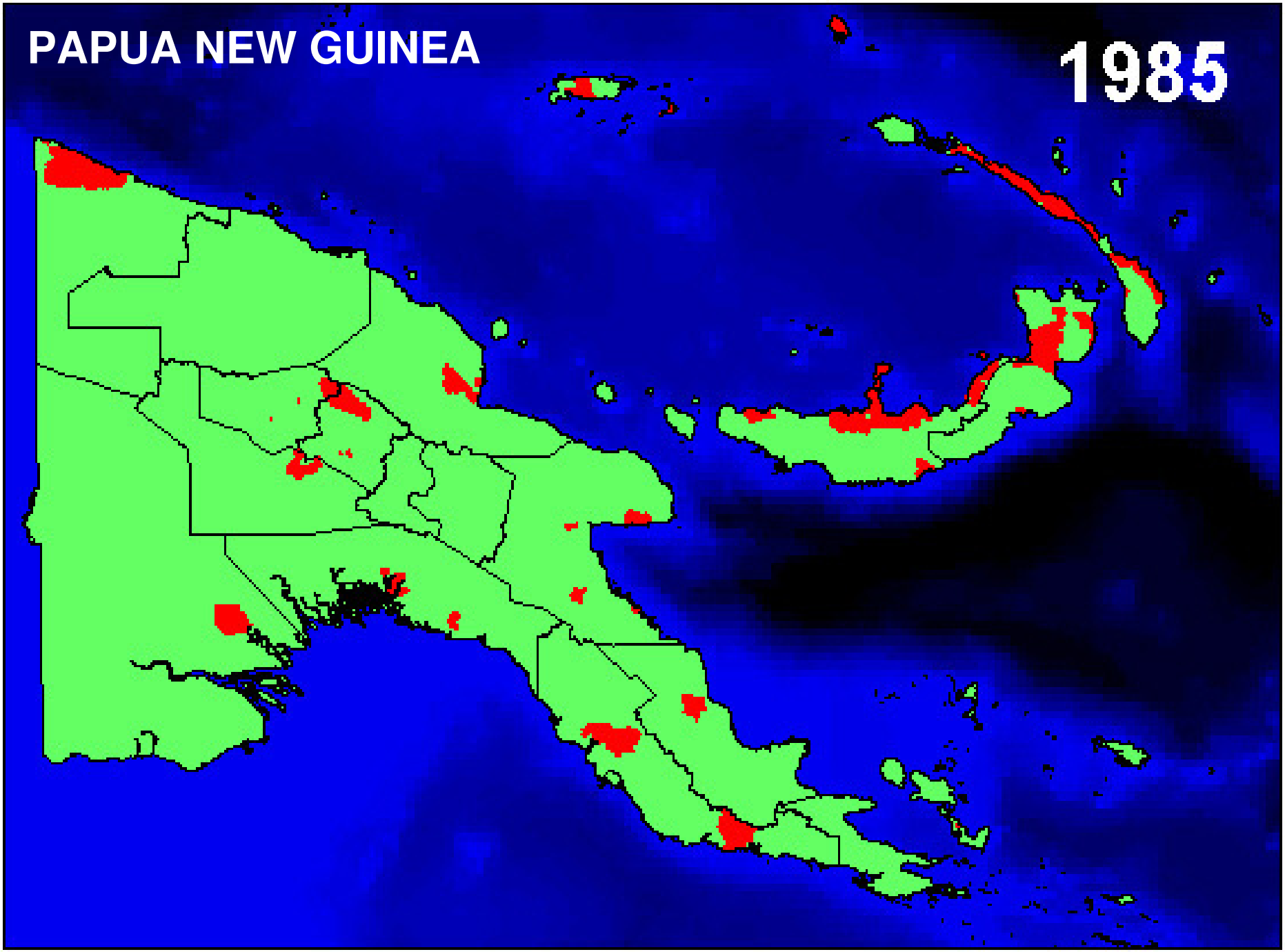
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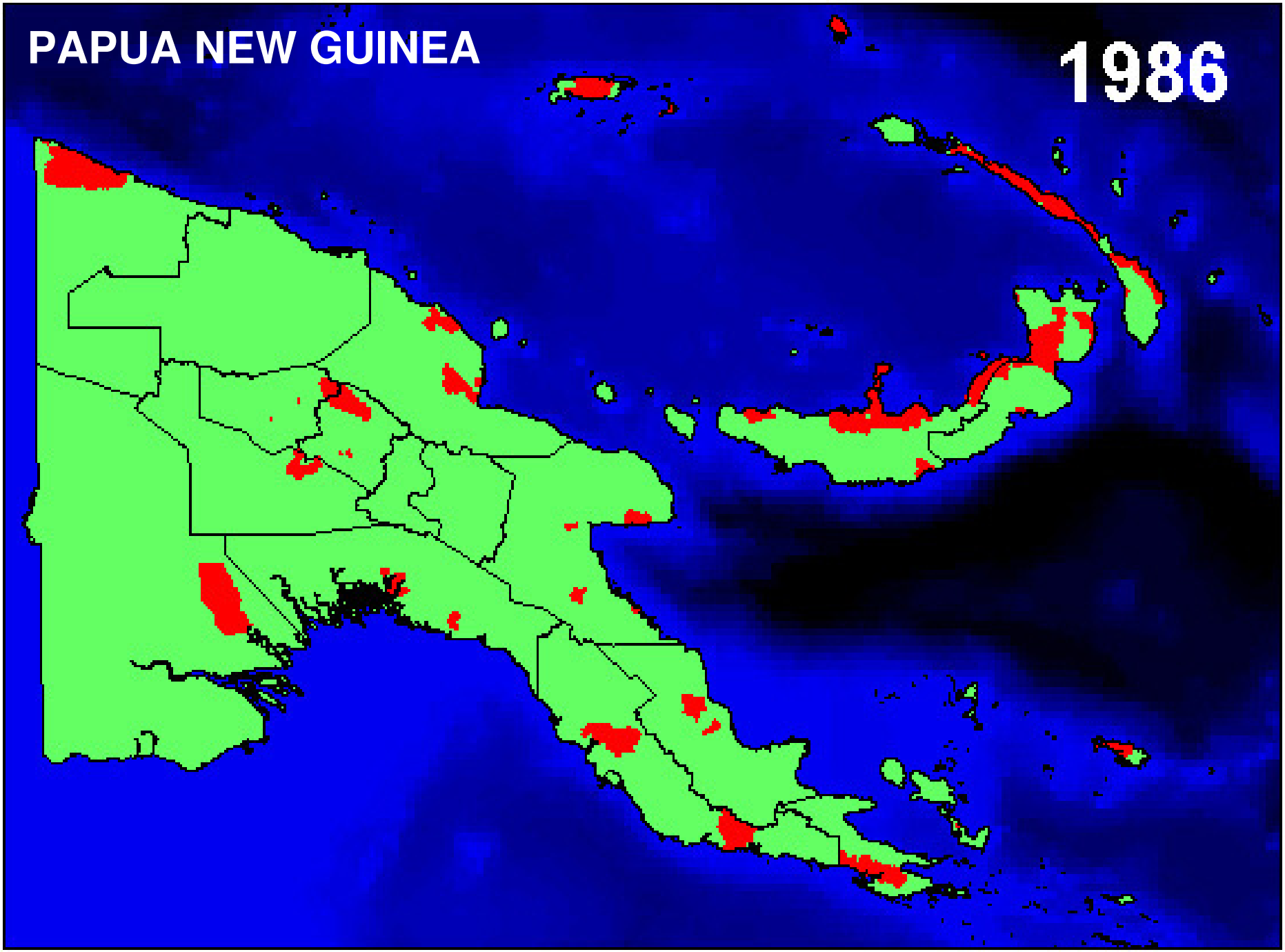
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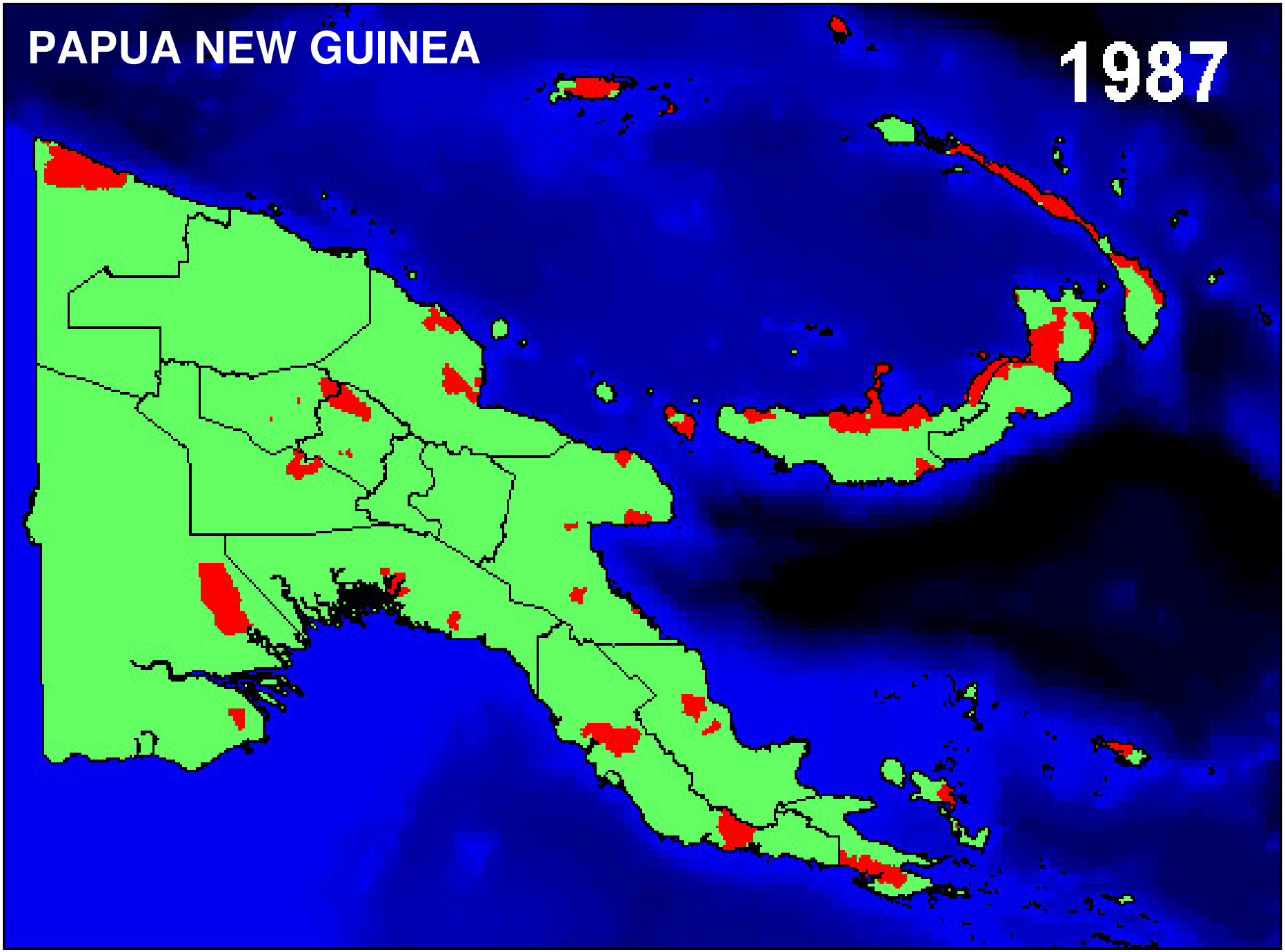
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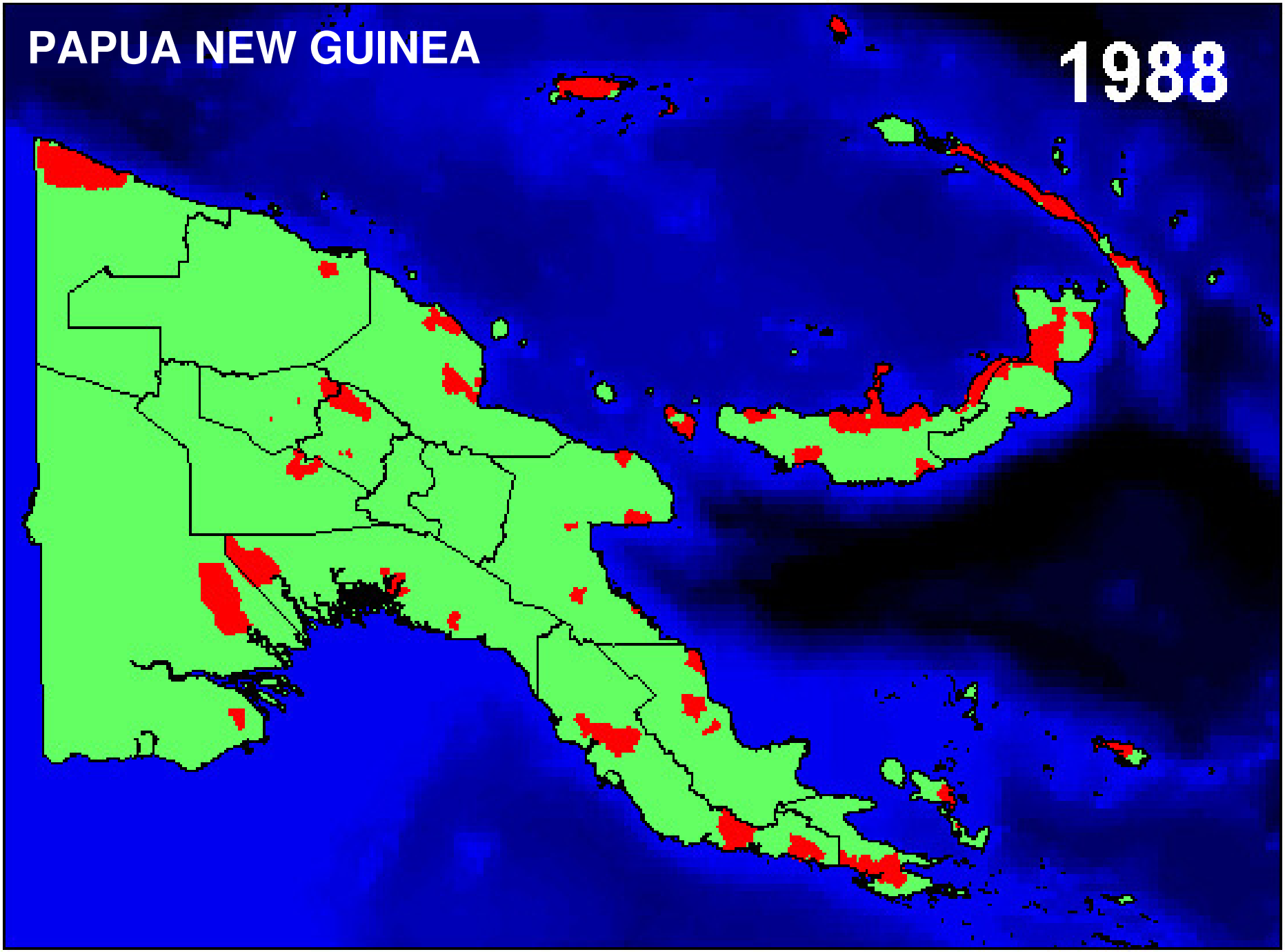
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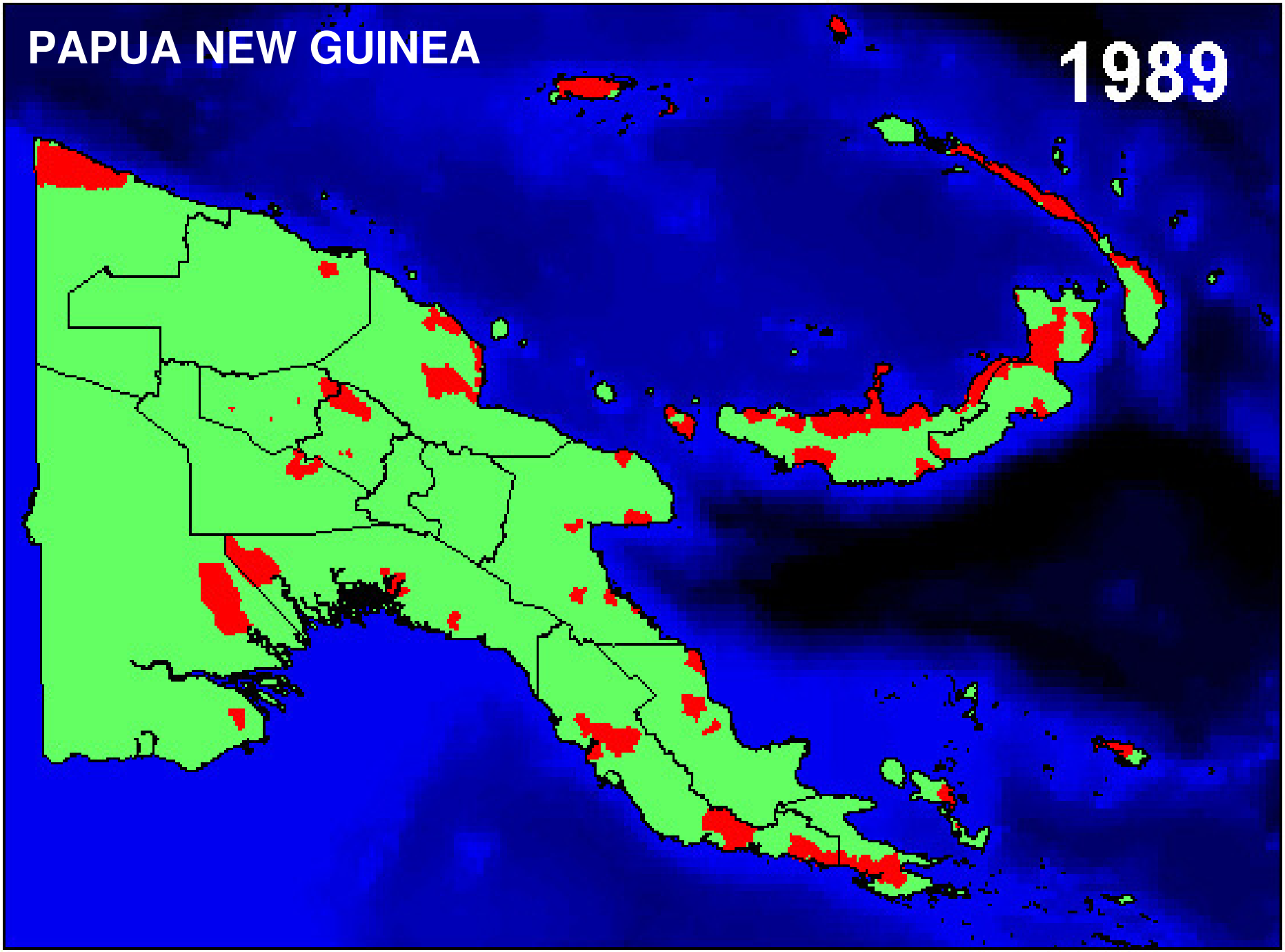
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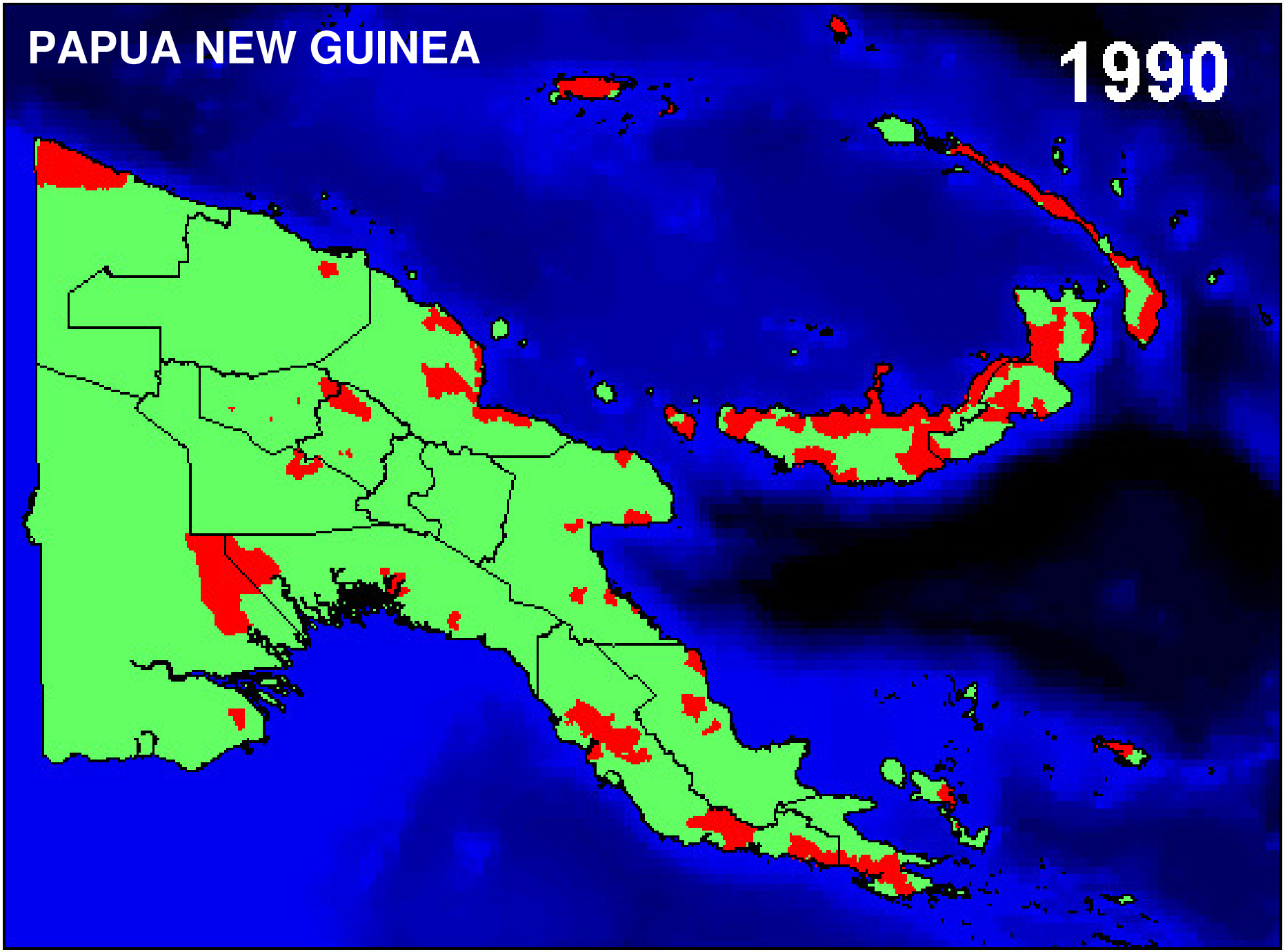
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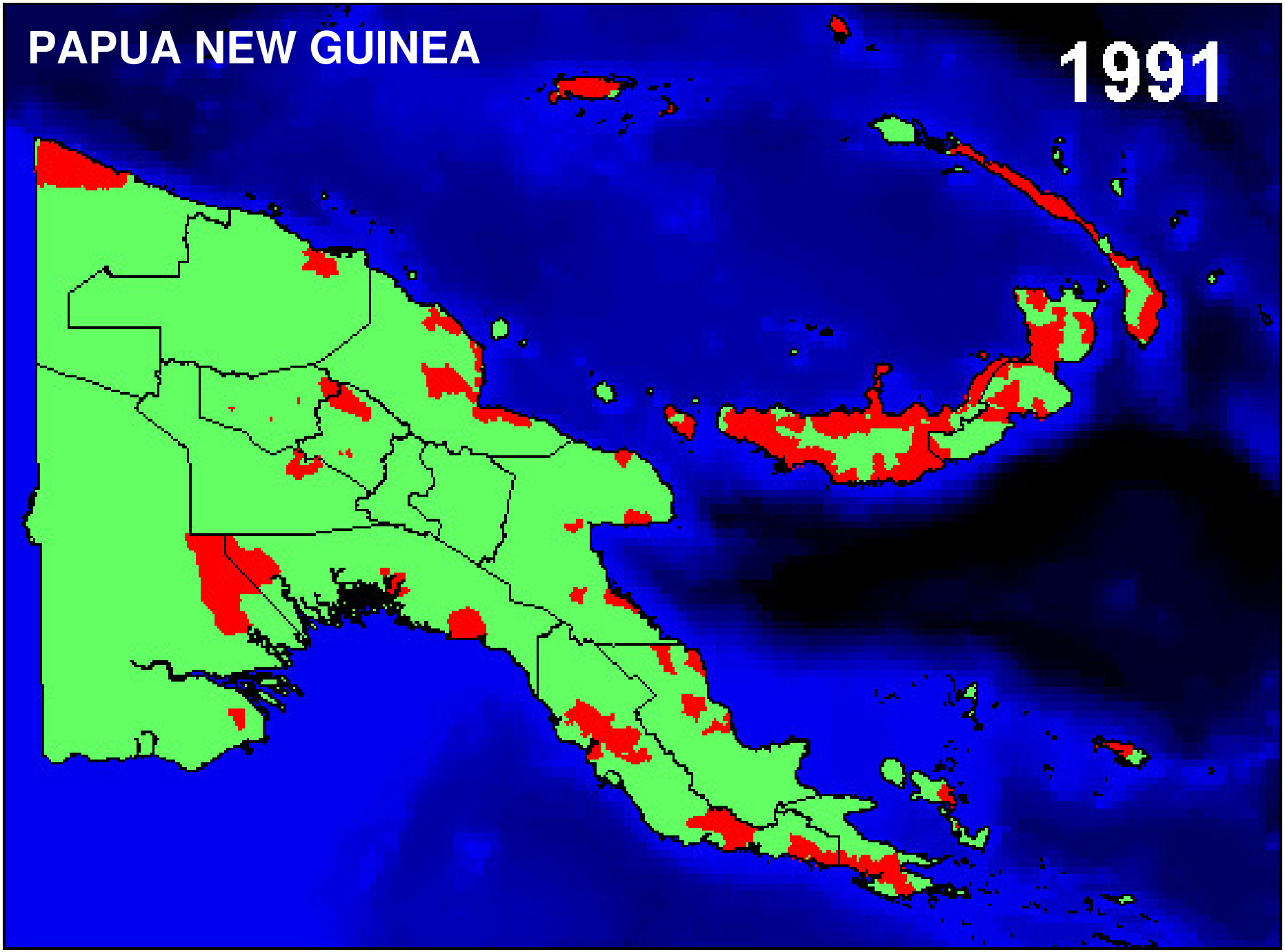
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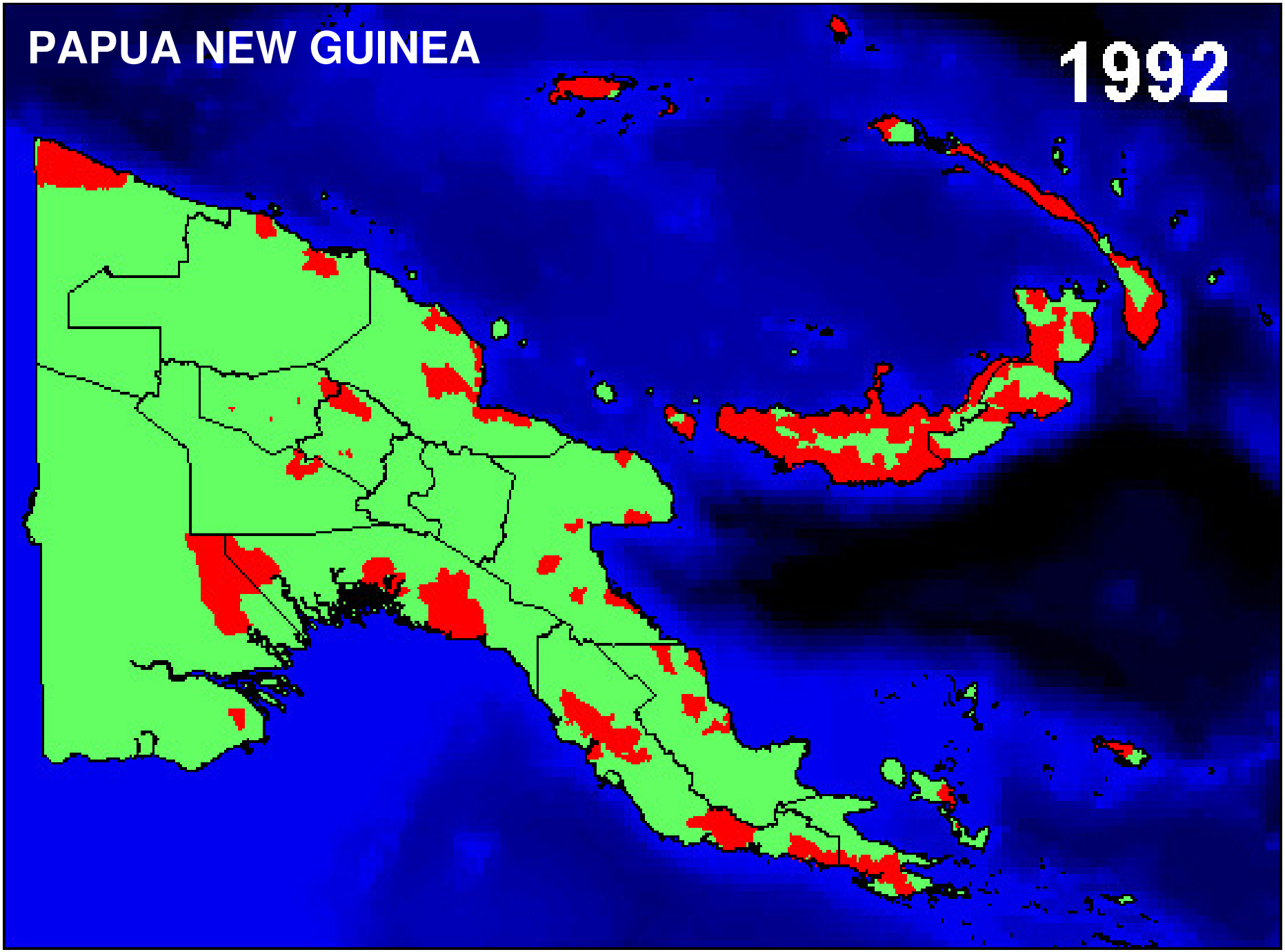
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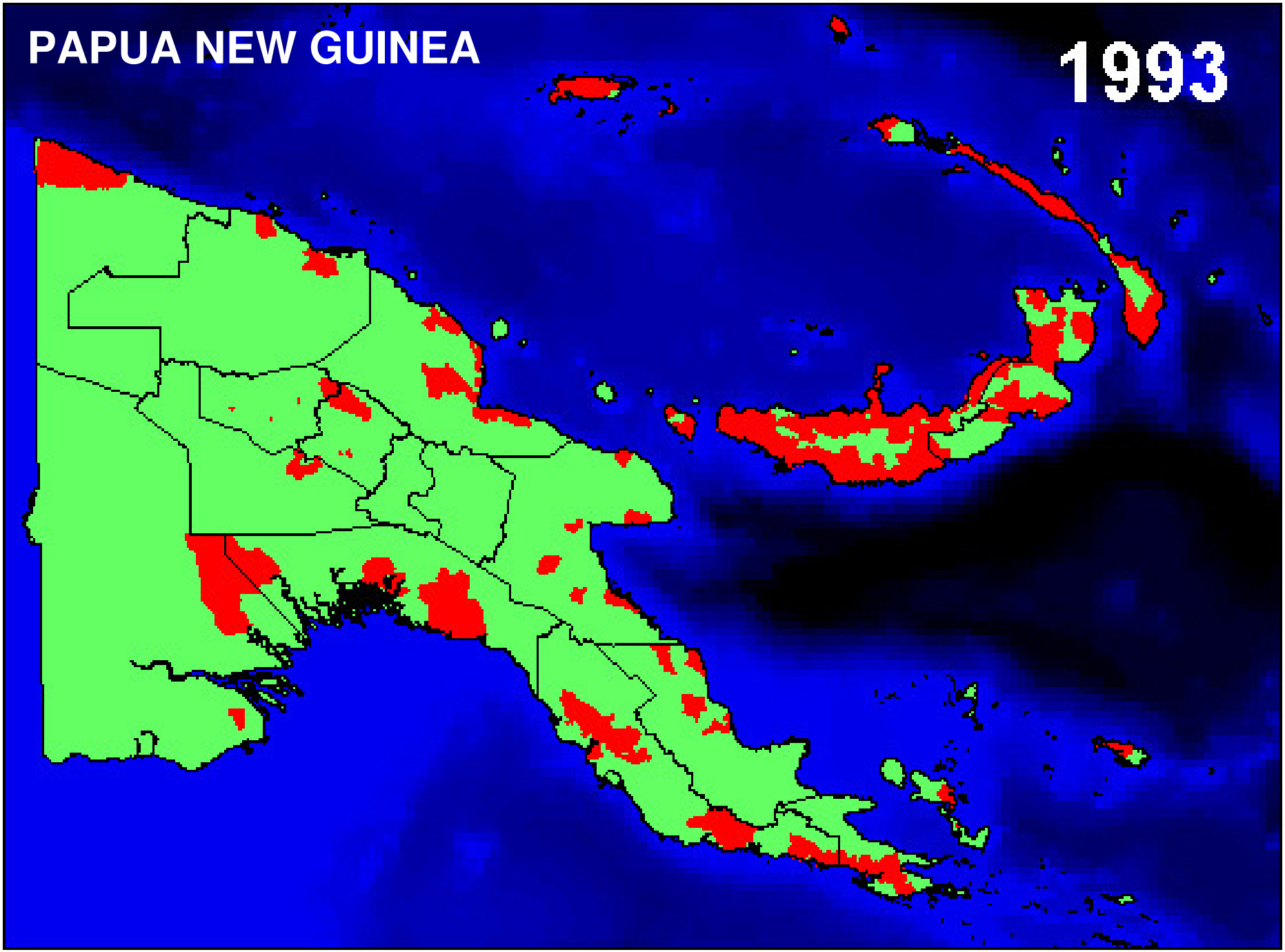
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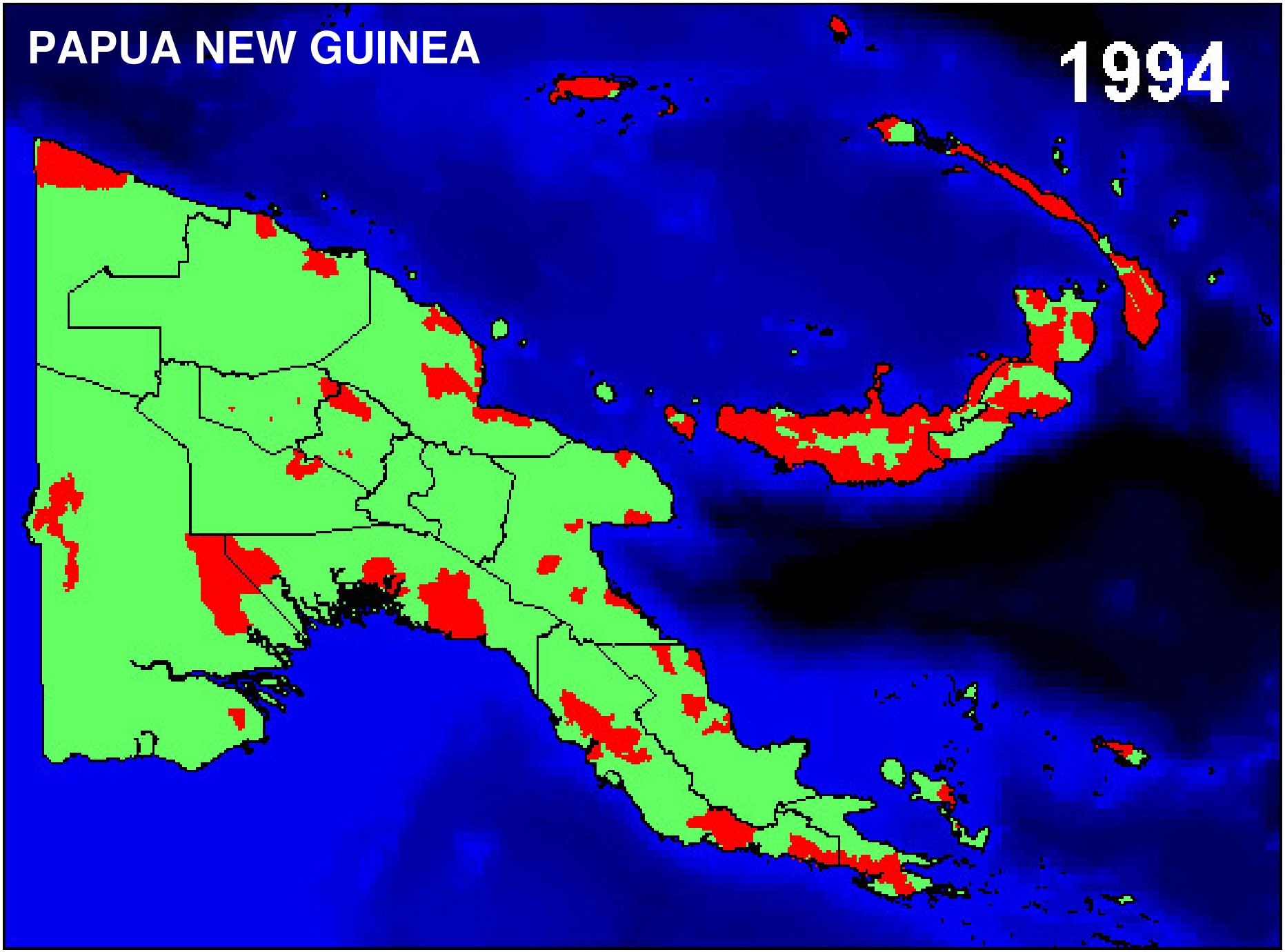
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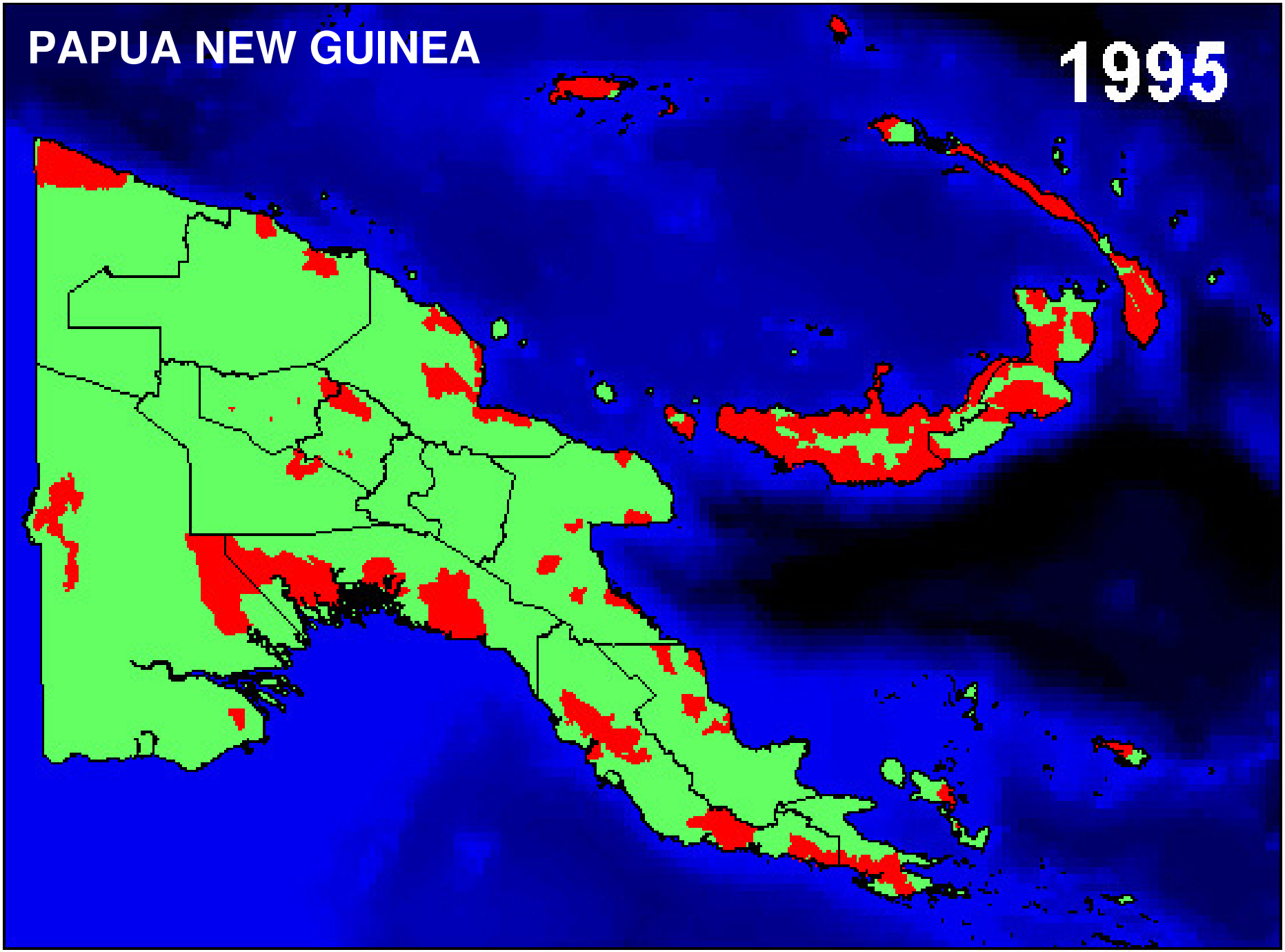
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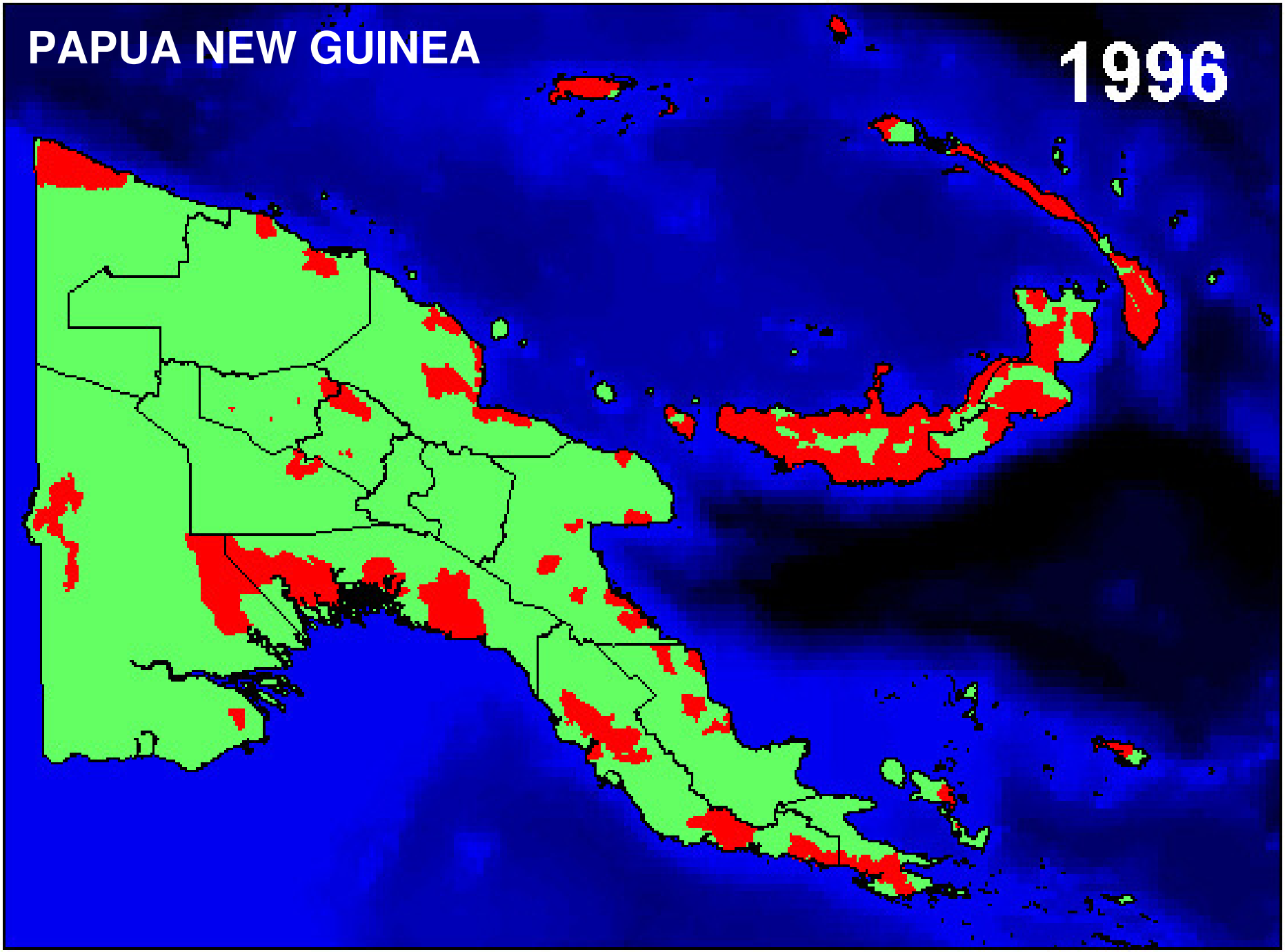
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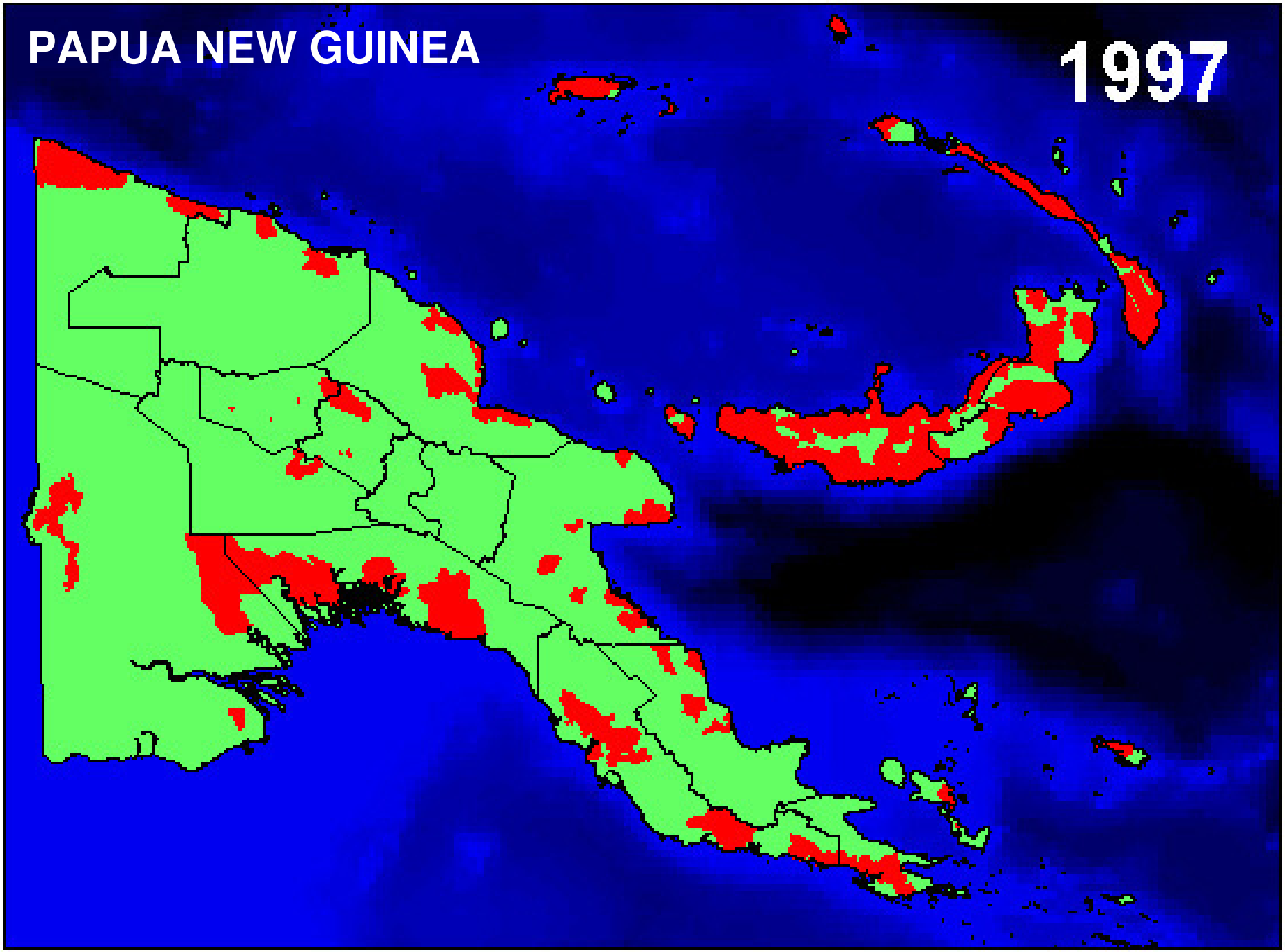
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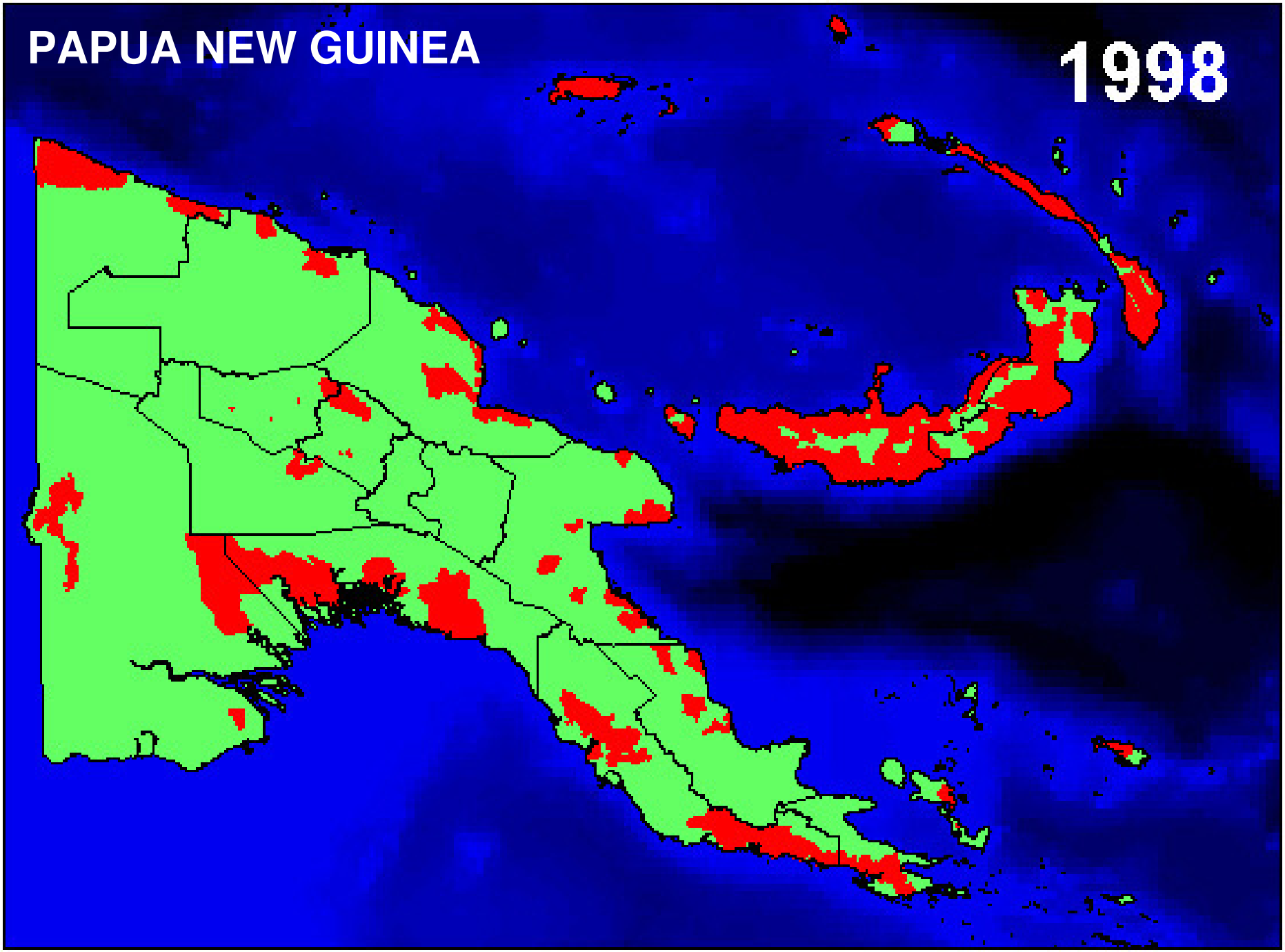
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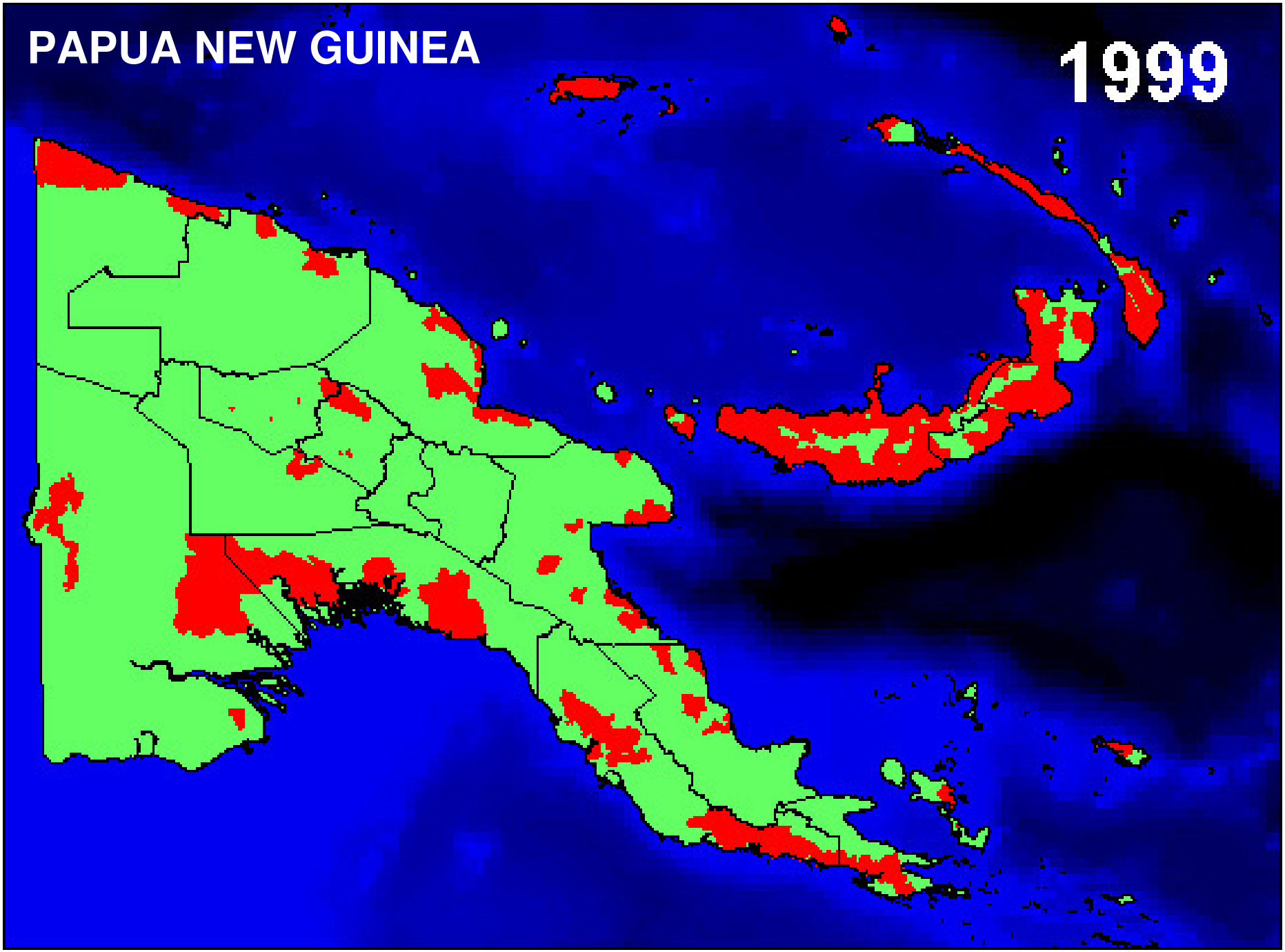
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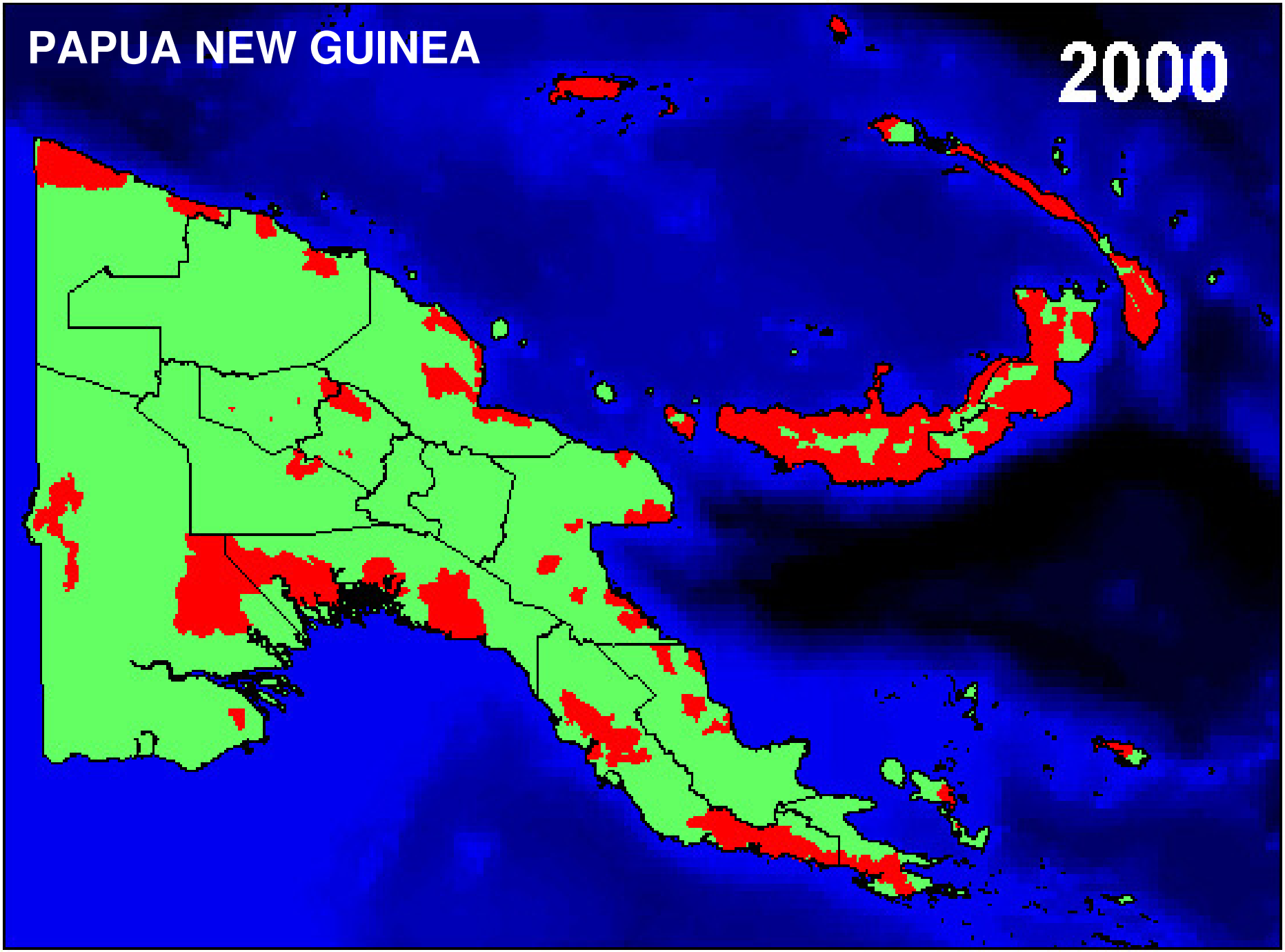
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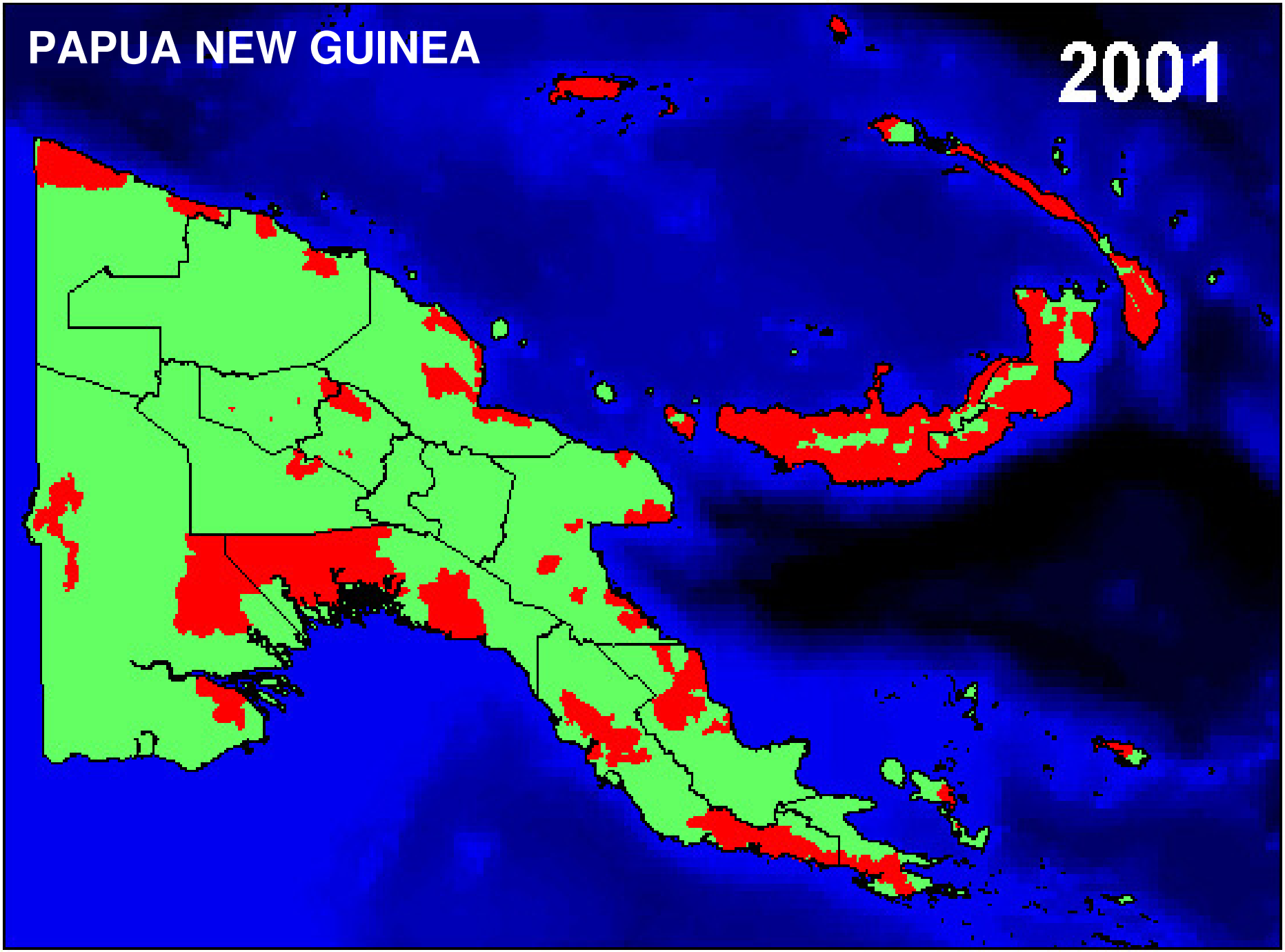
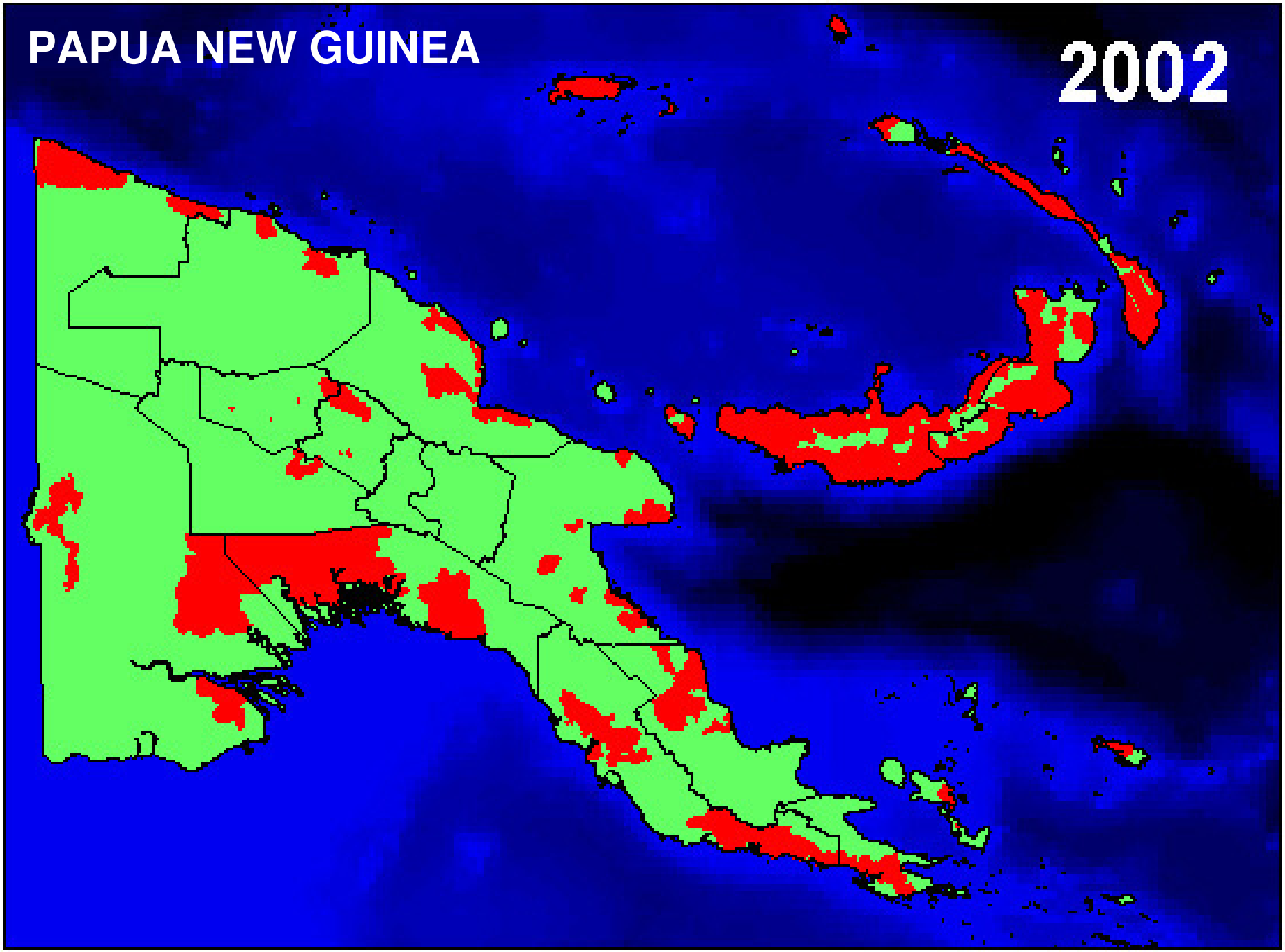
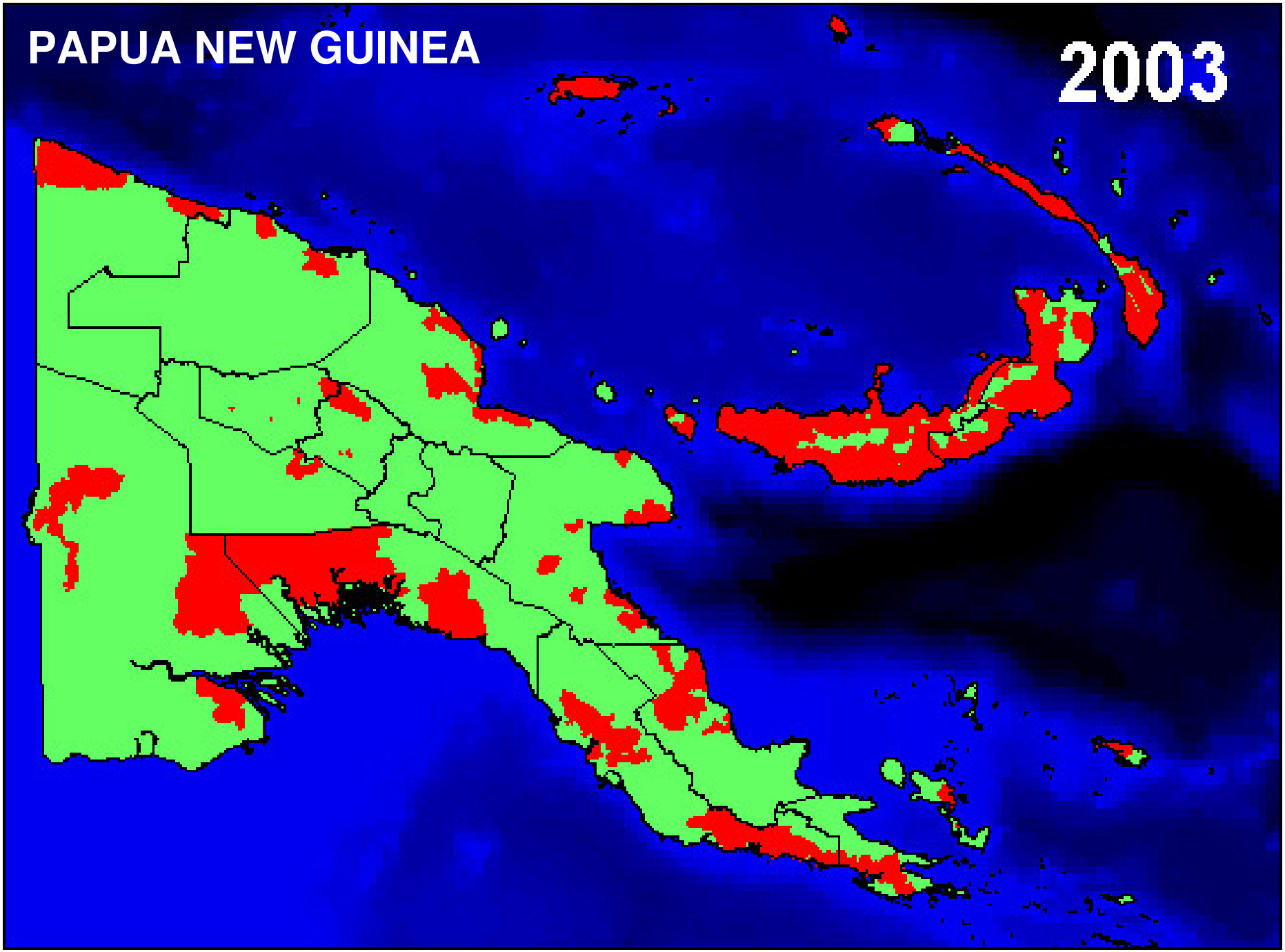
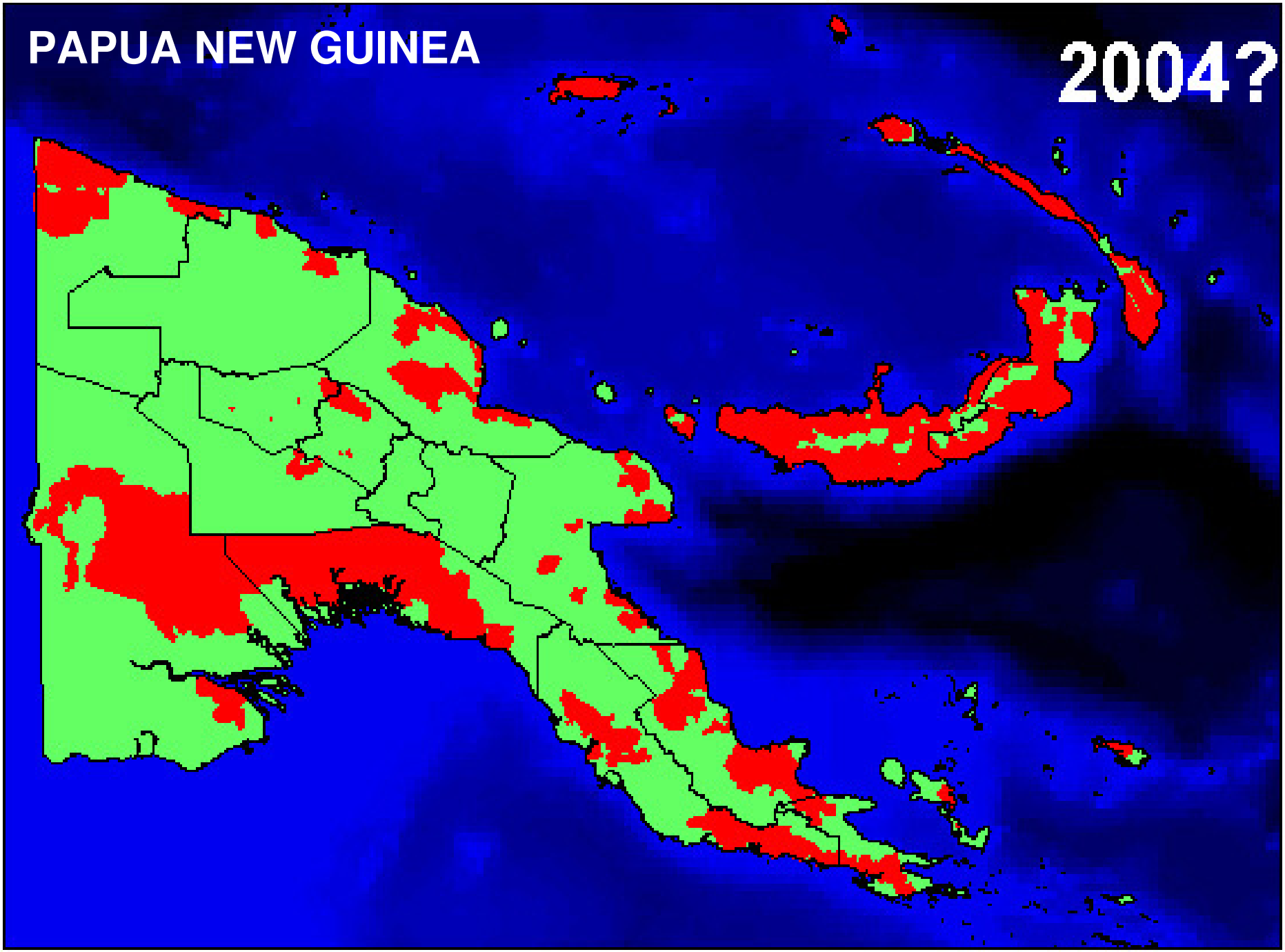
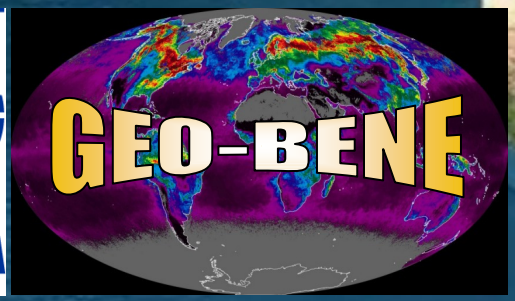

PAPUA NEW GUINEA
2001


PAPUA NEW GUINEA
2002


PAPUA NEW GUINEA
2003


PAPUA NEW GUINEA
2004?

Global Earth Observations:
Benefit Analysis — Now, Next and Emerging

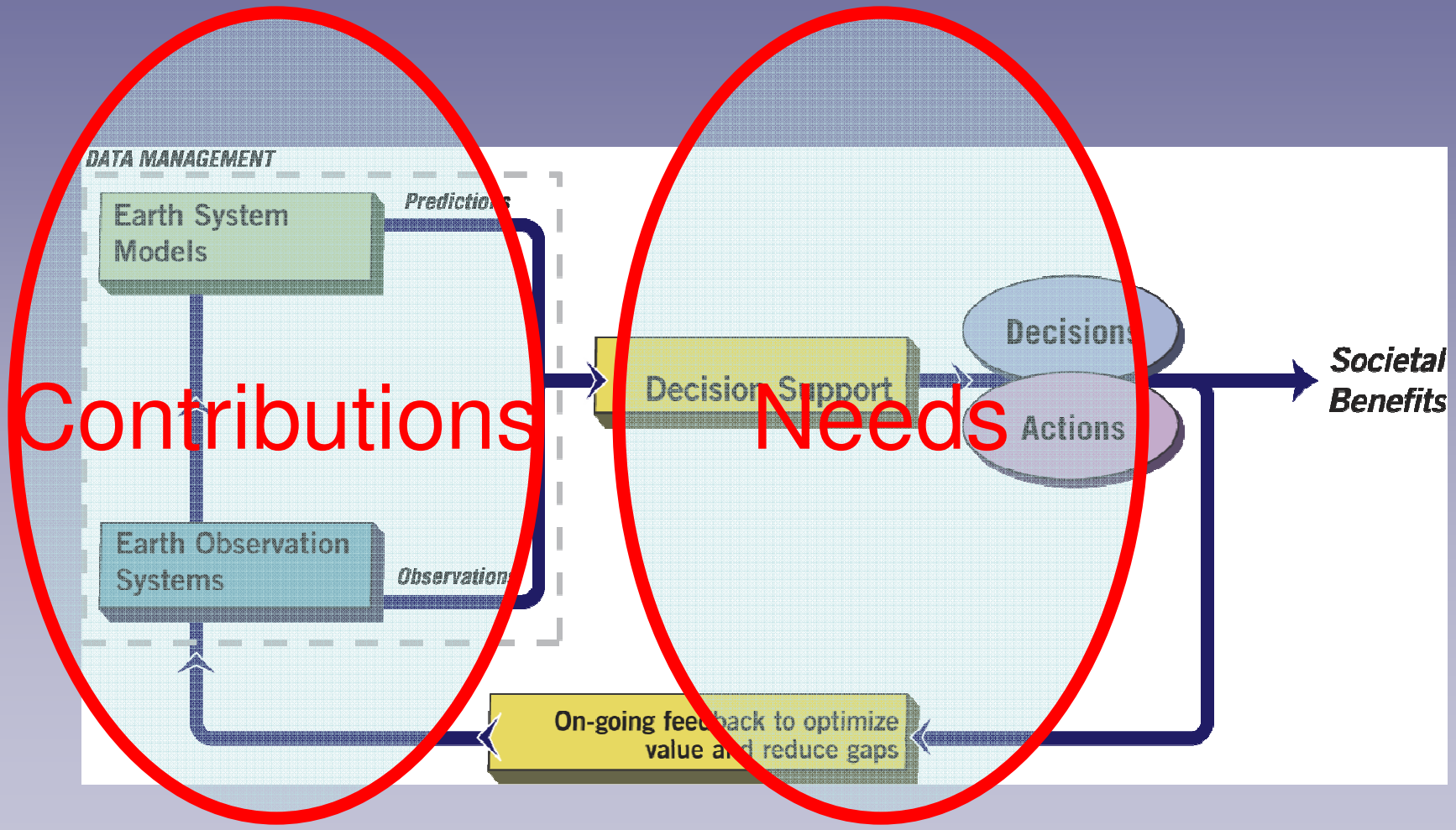


Michael Obersteiner

UN/Austria/ESA Symposium

Graz, 12–15 September 2006

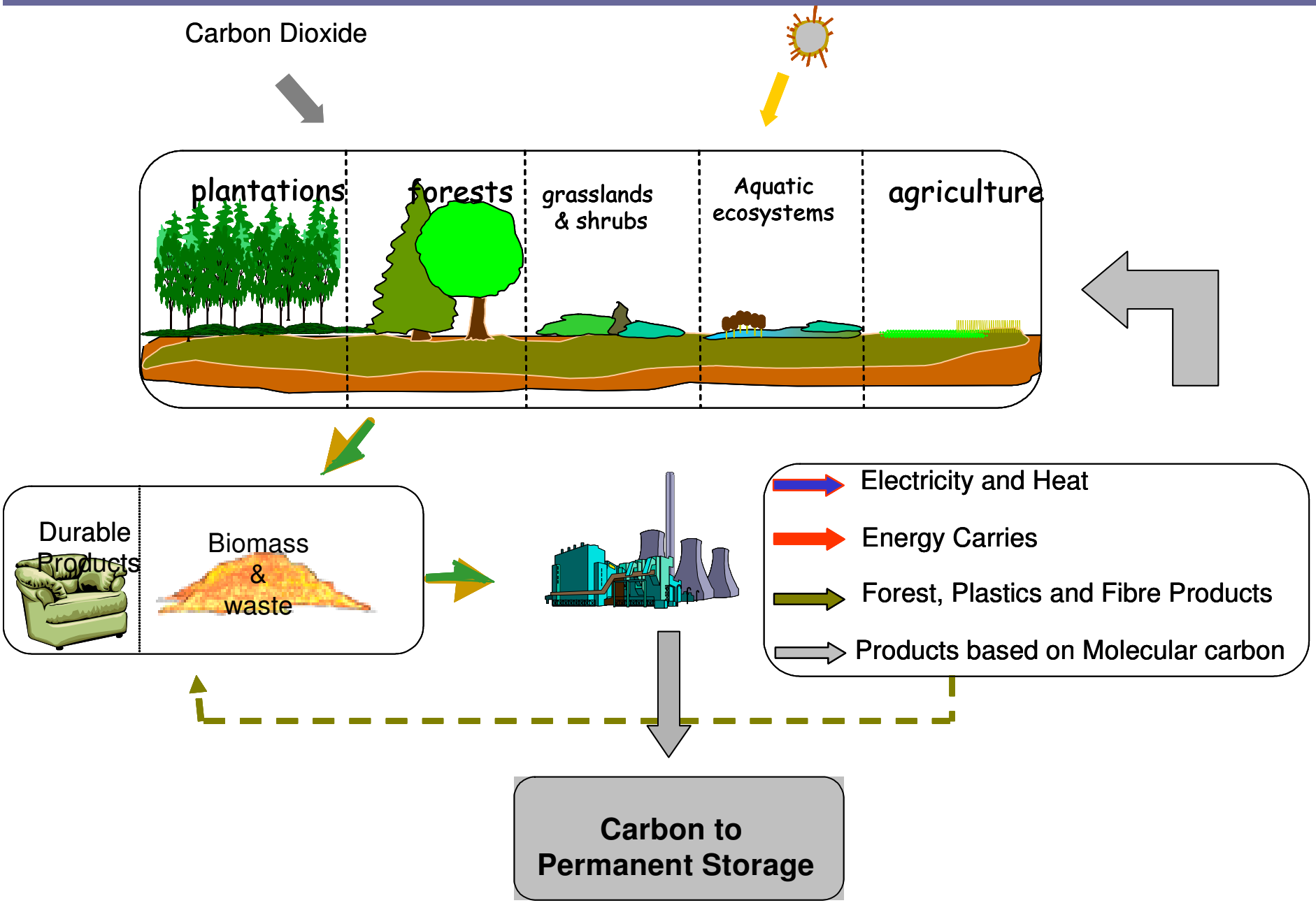
Linking Earth Observations to Societal Benefits



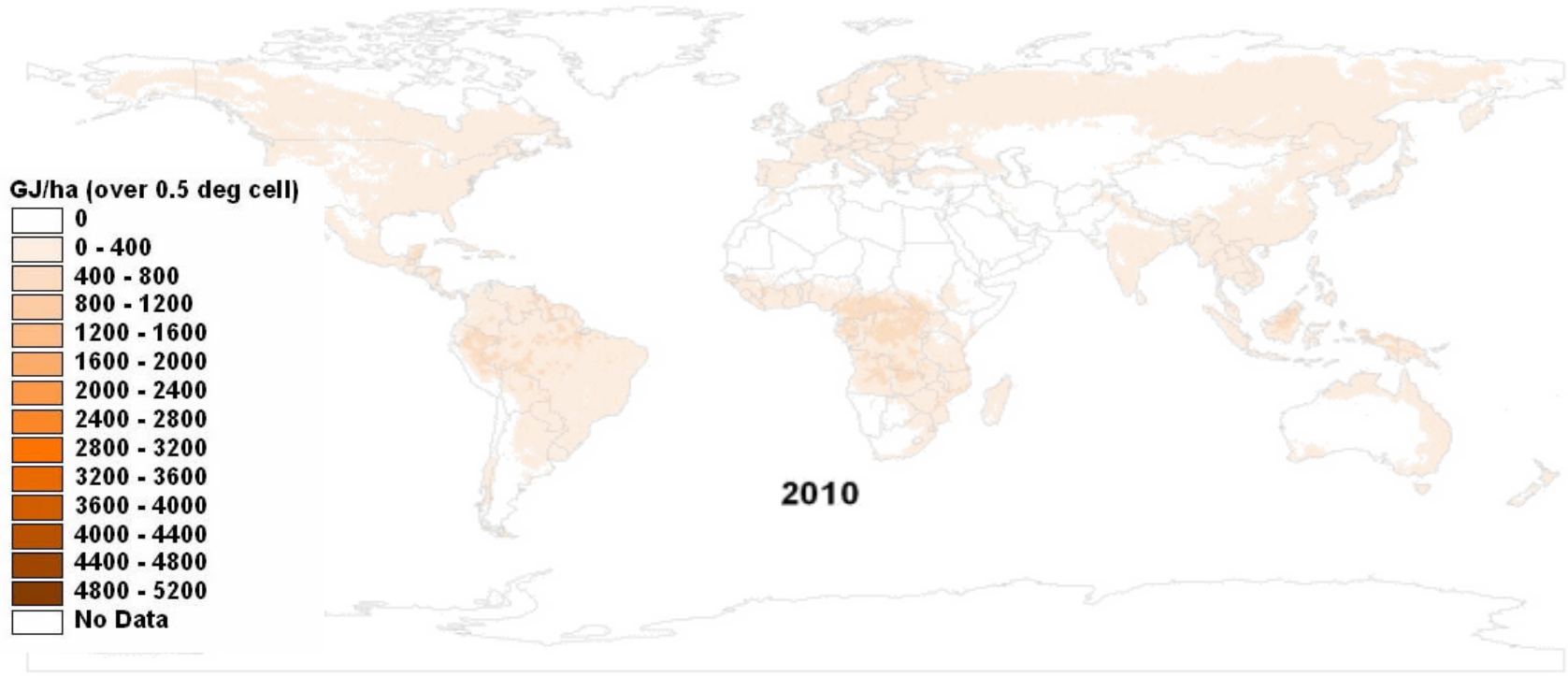
Case Studies

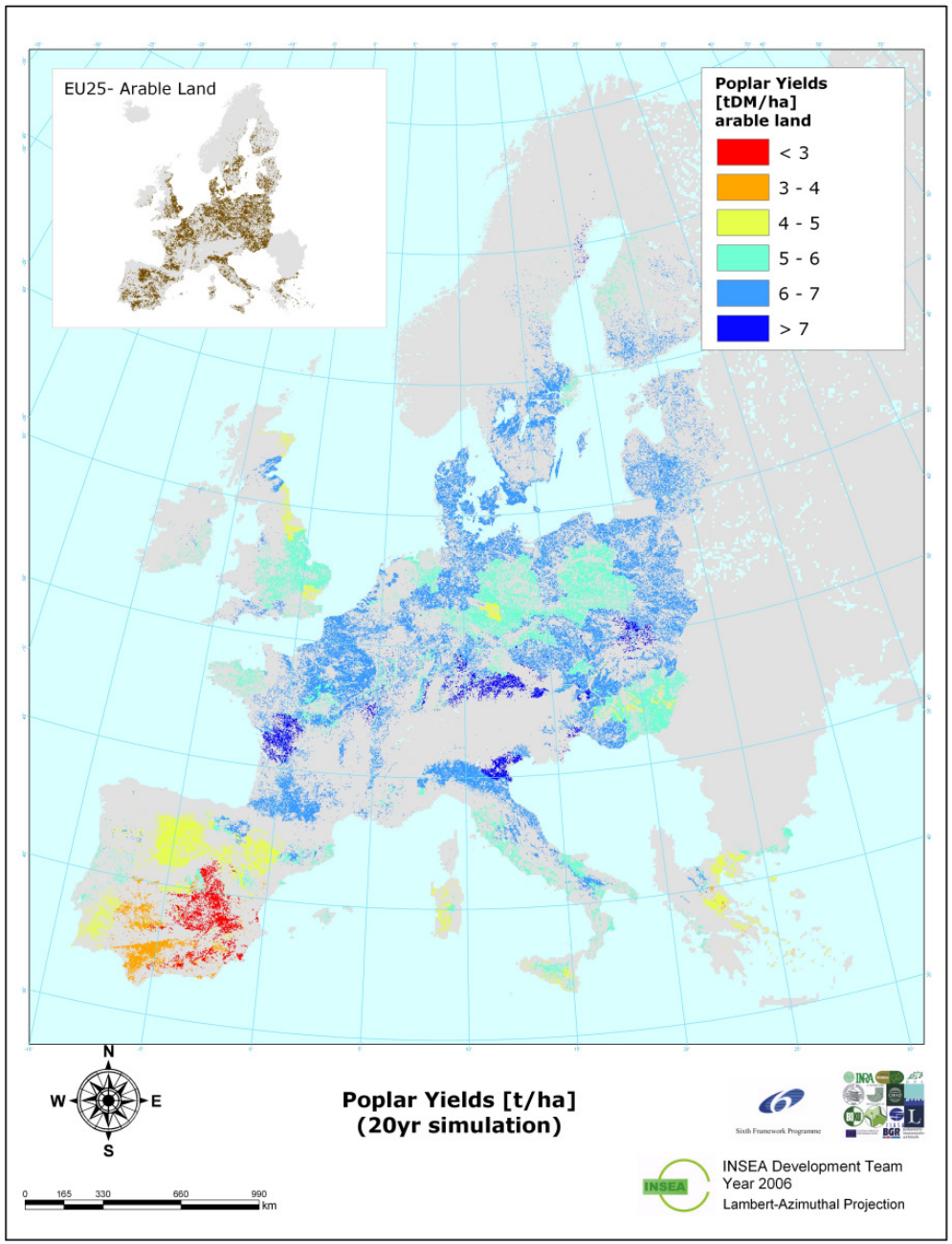
- Transport Fuels Production from Biomass and Uncertainty in Land Information
- The Impact of Hurricane Forecast on Oil and Gas Industry Operations
- Unit Commitment Problem in Power Plants with Different Weather and Climate Forecasts

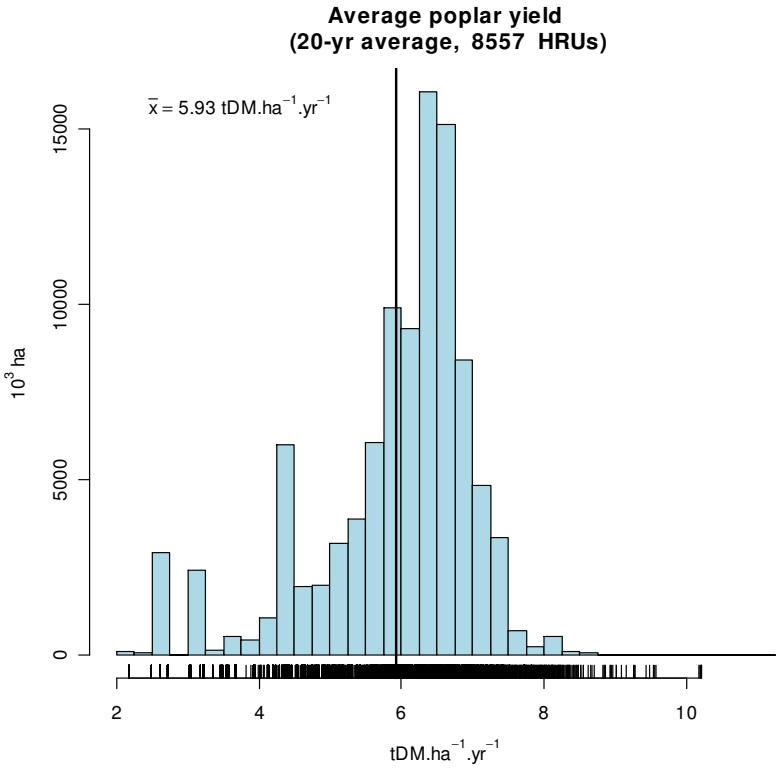
Land Information and Transport Fuel Production

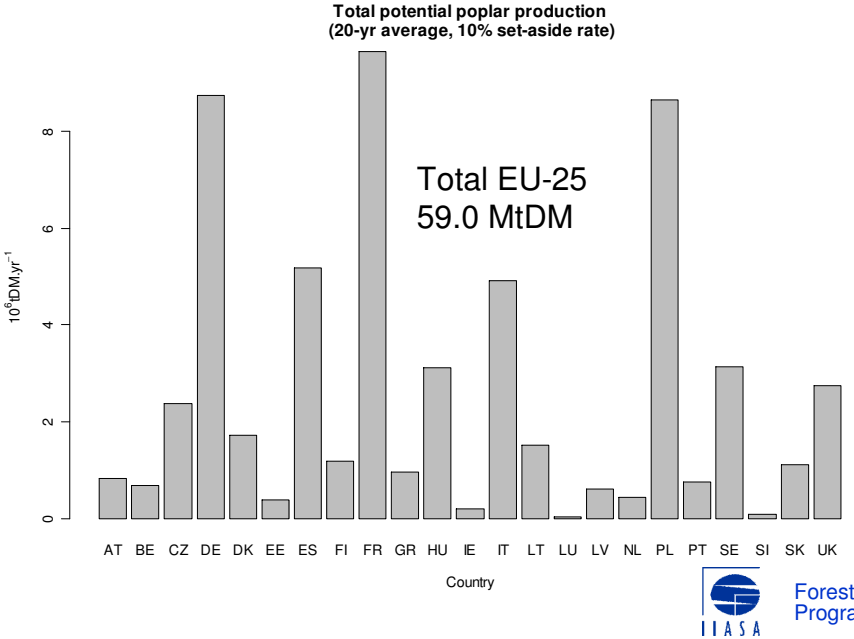

Carbon Dioxide
plantations
forests
grasslands & shrubs
Aquatic ecosystems
agriculture
Durable Products
Biomass & waste
Electricity and Heat
Energy Carries
Forest, Plastics and Fibre Products
Products based on Molecular carbon
Carbon to Permanent Storage

Bioenergy Supply for 2000–2100
B1 (Price < 6$/GJ)









Forestry Program

Biomass Supply: Costs for Baden-Württemberg

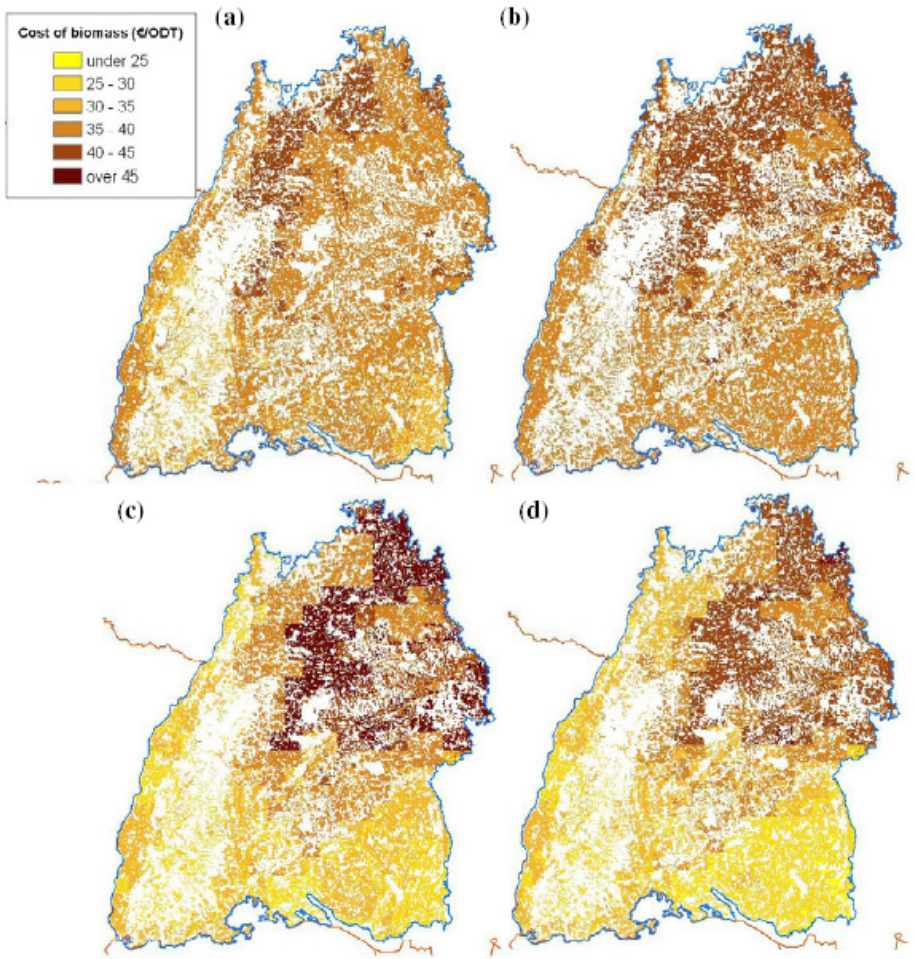
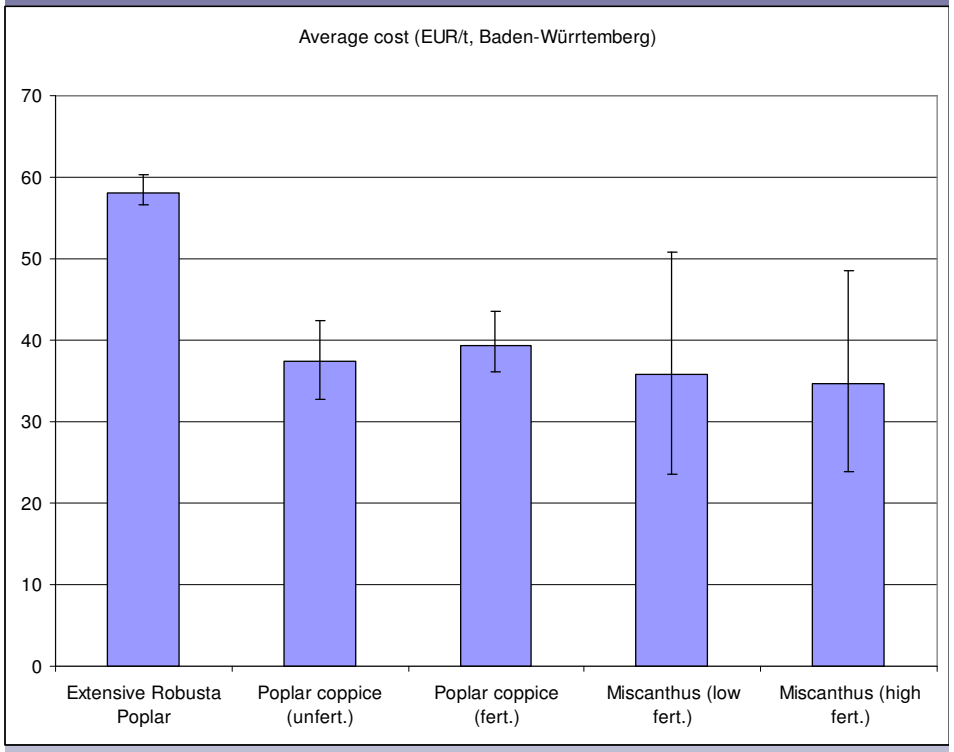


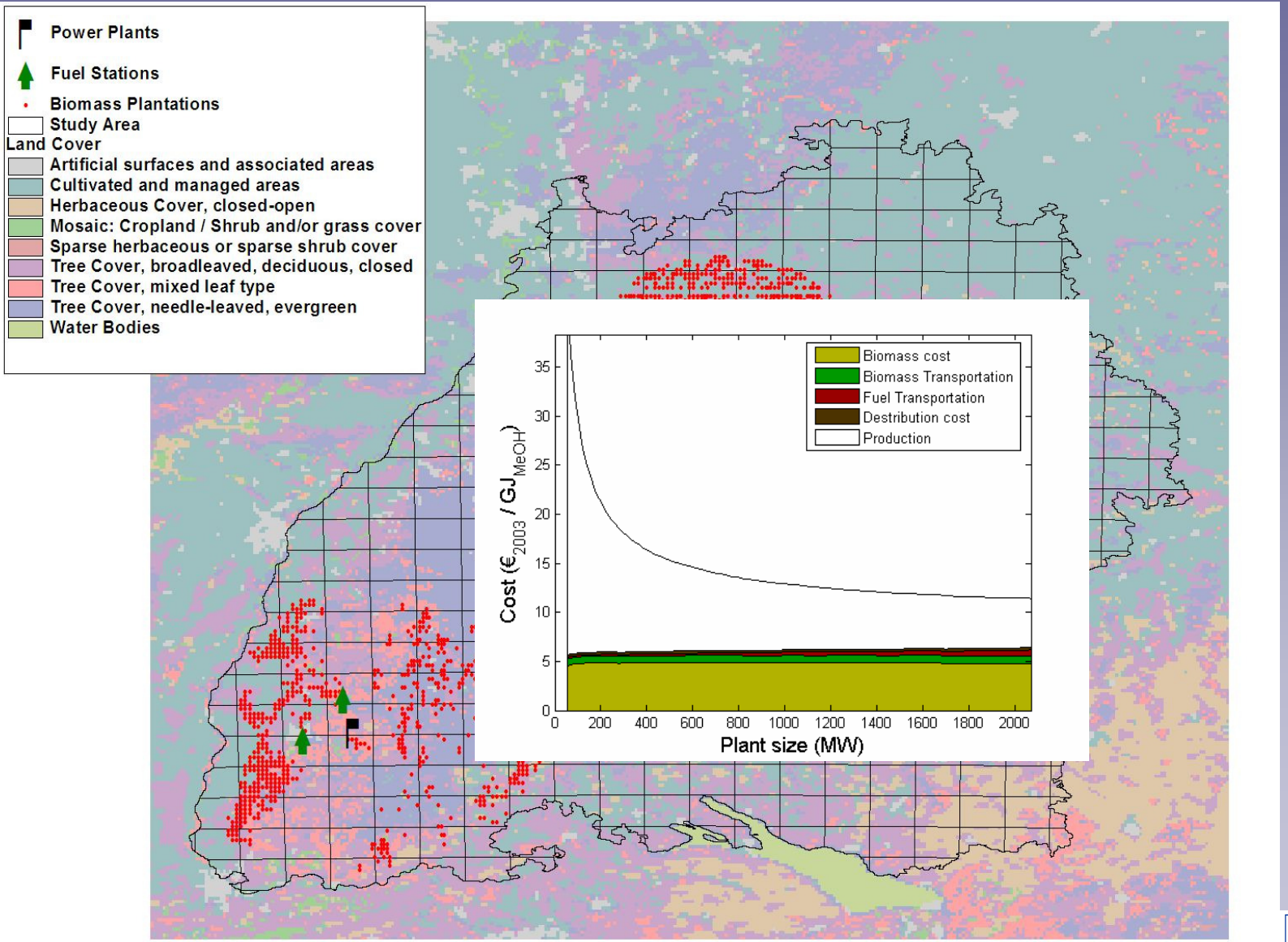
Figure 12: A comparison of estimated costs for biomass in different areas using different management options: (a) unfertilized poplar coppice,(b) poplar coppice fertilized with slurry, (c) miscanthus with lower fertilization, and (d) miscanthus with higher fertilization.



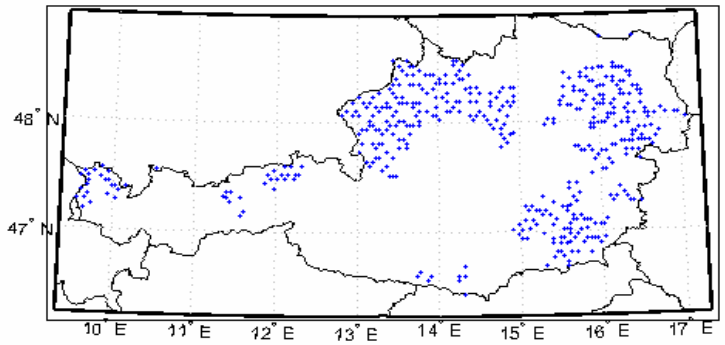
Source: Neuvonen, 2005

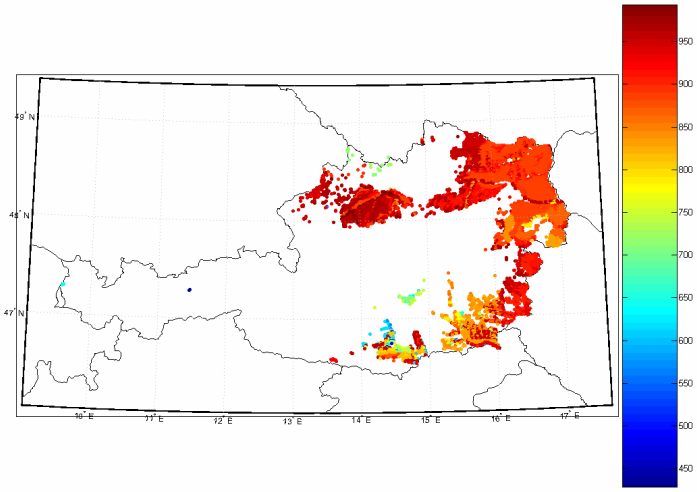
IIASA Forestry Program

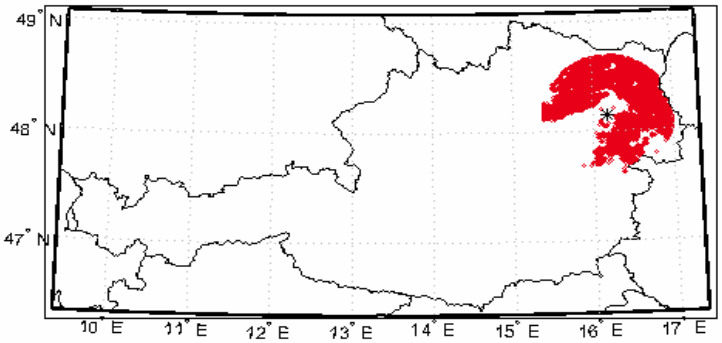
Methanol from Poplar:
10% Car Fleet, 8.3% Arable Land, 25 ha Plantation/100ha

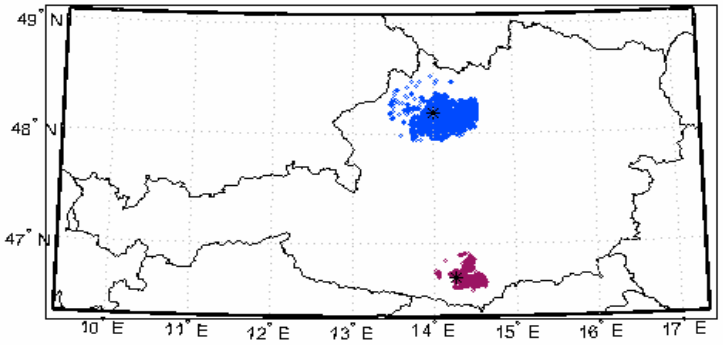


IIASA Forestry Program





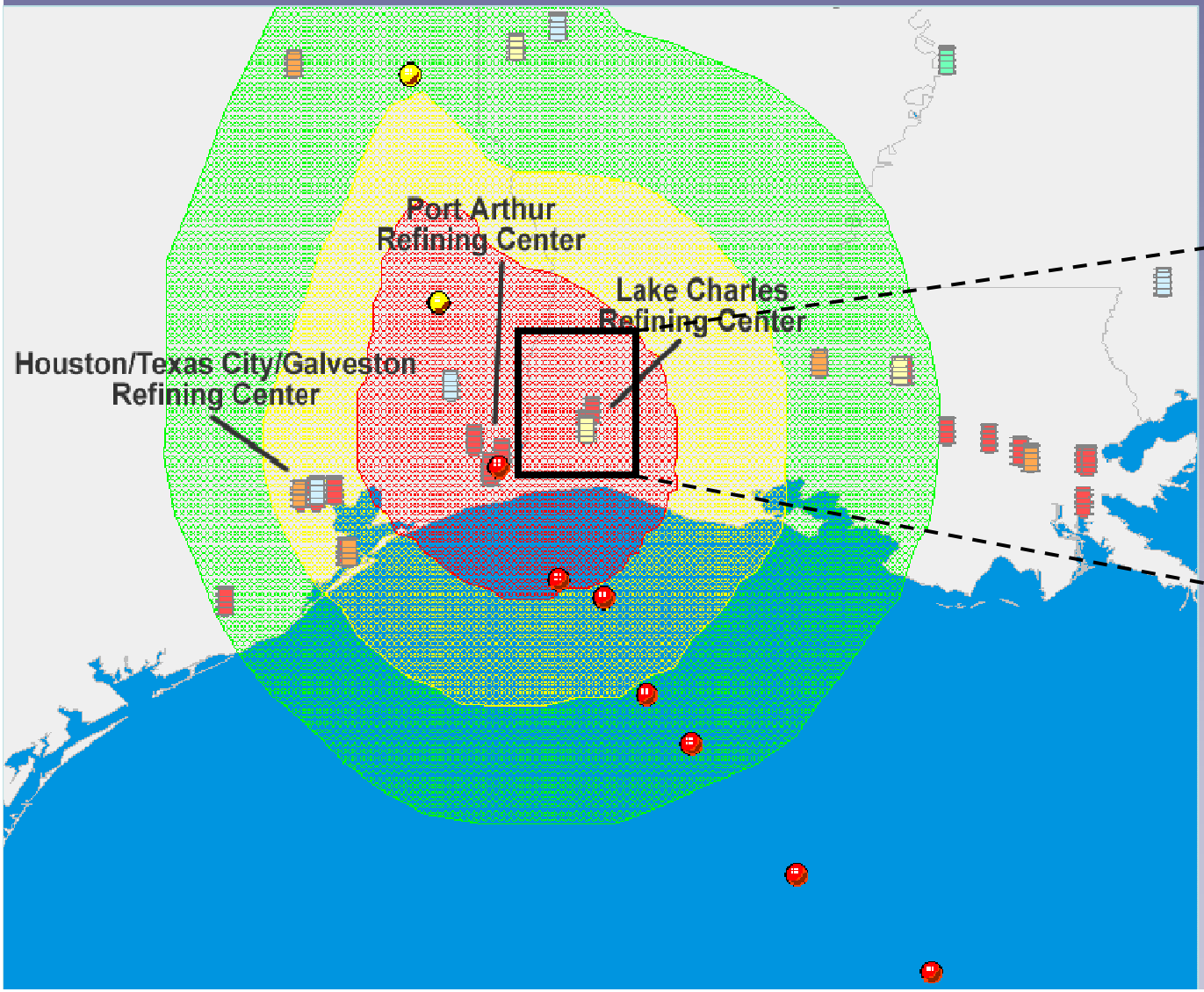




IIASA Forestry Program

Hurricane and Refinery

Hurricane Rita's Path:
24 September 2005



Valero Port Arthur Refinery

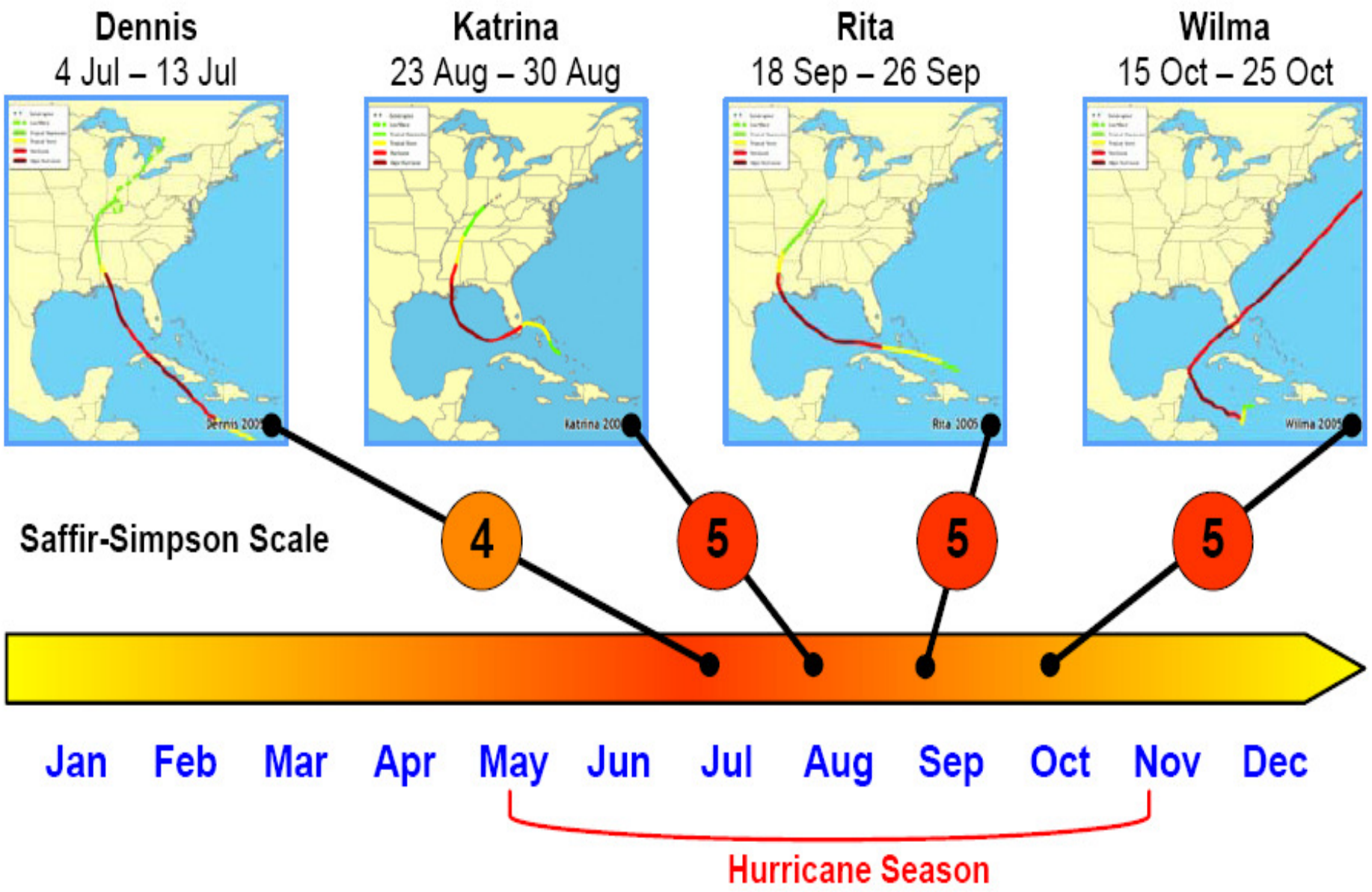
IIASA Forestry Program

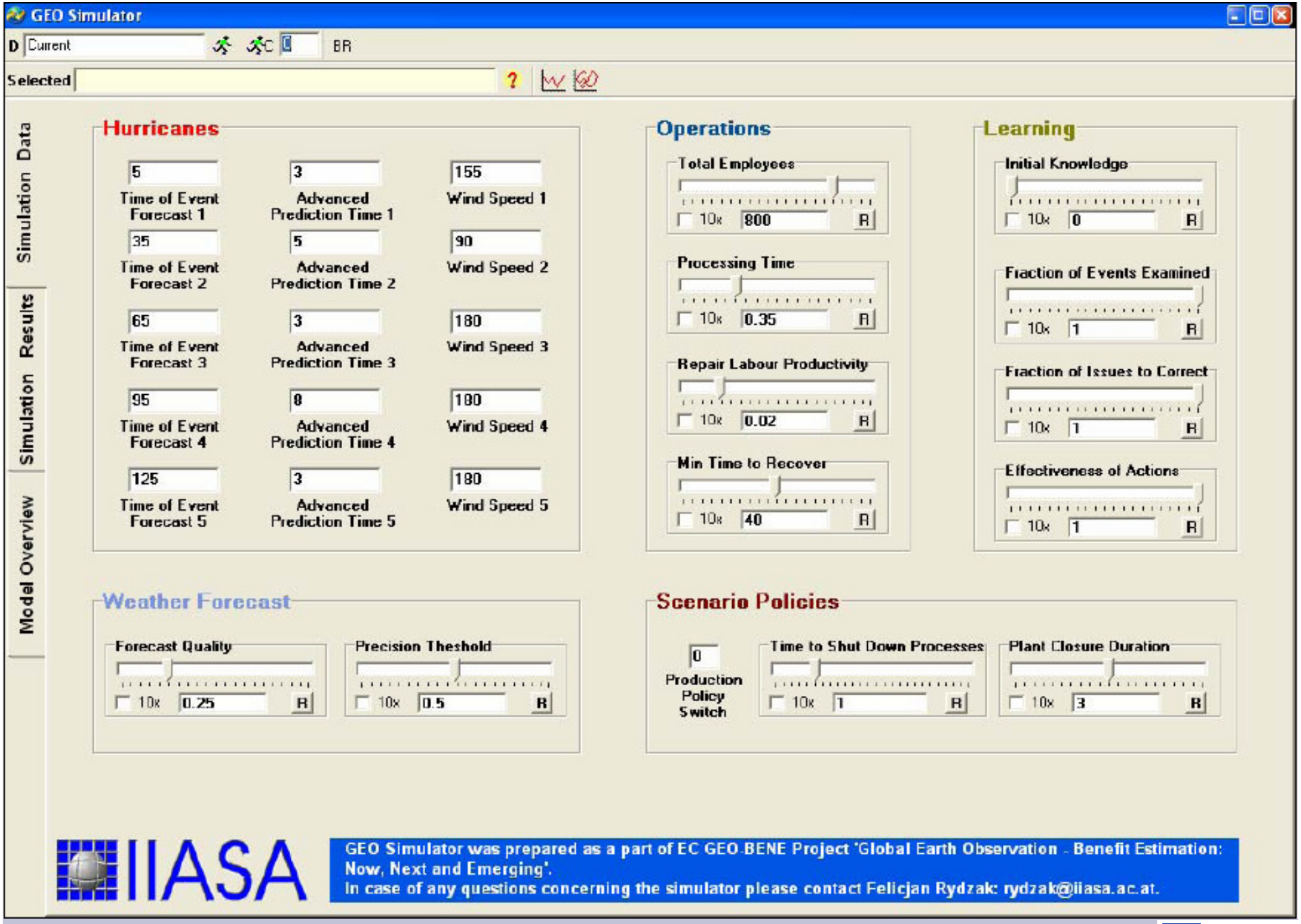
Recovery After Hurricanes

15 October 2005

- Three weeks after Rita, Port Arthur starts operations again
- Two other refineries in the Port Arthur area remain closed
- Three refineries in Louisiana, damaged during Katrina, are still shut down

National Public Radio (NPR)
http://www.npr.org/


Dennis
4 Jul – 13 Jul
Katrina
23 Aug – 30 Aug
Rita
18 Sep – 26 Sep
Wilma
15 Oct – 25 Oct
Saffir-Simpson Scale
4
5
5
5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Hurricane Season


GEO Simulator
D Current
BR
Selected
Simulation Data
Simulation Results
Model Overview
Hurricanes
5
Time of Event Forecast 1
3
Advanced Prediction Time 1
155
Wind Speed 1
35
Time of Event Forecast 2
5
Advanced Prediction Time 2
90
Wind Speed 2
65
Time of Event Forecast 3
3
Advanced Prediction Time 3
180
Wind Speed 3
95
Time of Event Forecast 4
8
Advanced Prediction Time 4
180
Wind Speed 4
125
Time of Event Forecast 5
3
Advanced Prediction Time 5
180
Wind Speed 5
Operations
Total Employees
10x
800
R
Processing Time
10x
0.35
R
Repair Labour Productivity
10x
0.02
R
Min Time to Recover
10x
40
R
Learning
Initial Knowledge
10x
0
R
Fraction of Events Examined
10x
1
R
Fraction of Issues to Correct
10x
1
R
Effectiveness of Actions
10x
1
R
Weather Forecast
Forecast Quality
10x
0.25
R
Precision Theshold
10x
0.5
R
Scenario Policies
0
Production Policy Switch
Time to Shut Down Processes
10x
1
R
Plant Closure Duration
10x
3
R
IIASA
GEO Simulator was prepared as a part of EC GEO-BENE Project 'Global Earth Observation - Benefit Estimation: Now, Next and Emerging'.
In case of any questions concerning the simulator please contact Felicjan Rydzak: rydzak@iiasa.ac.at.

GEO Simulator

D Current C BR

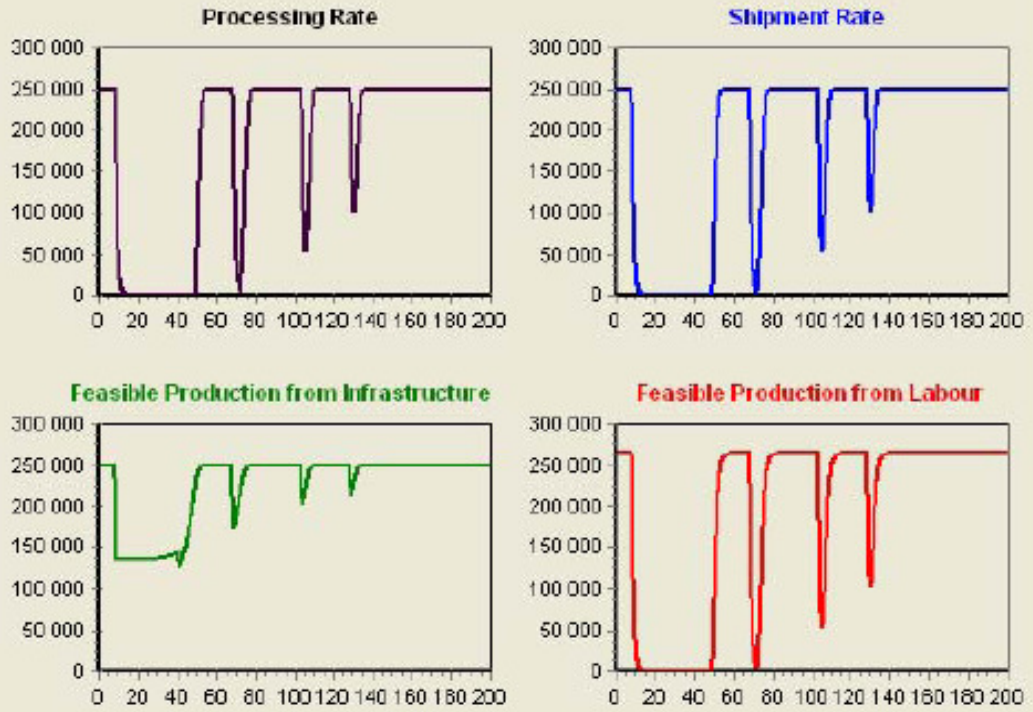
Selected

Simulation Data | Simulation Results | Model Overview

Hurricanes Impact

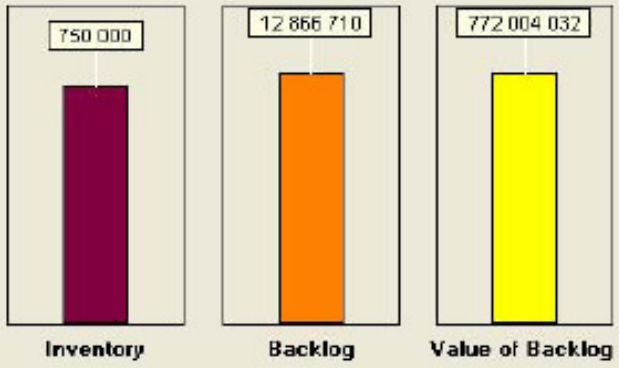
Hurricane Category | Perceived Event Severity | Time to Recover

Operations

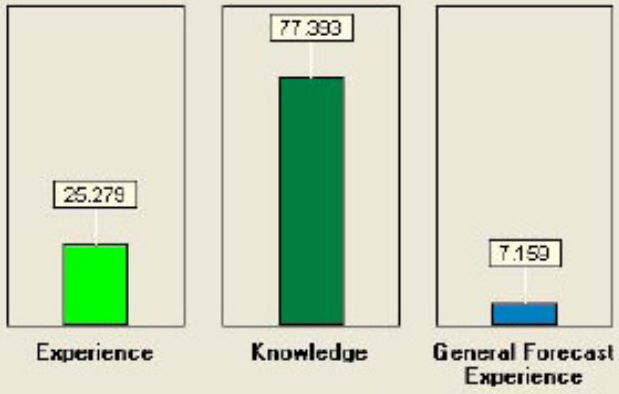


Economic Value

Unit Price per Barrel 60



Experience and Knowledge

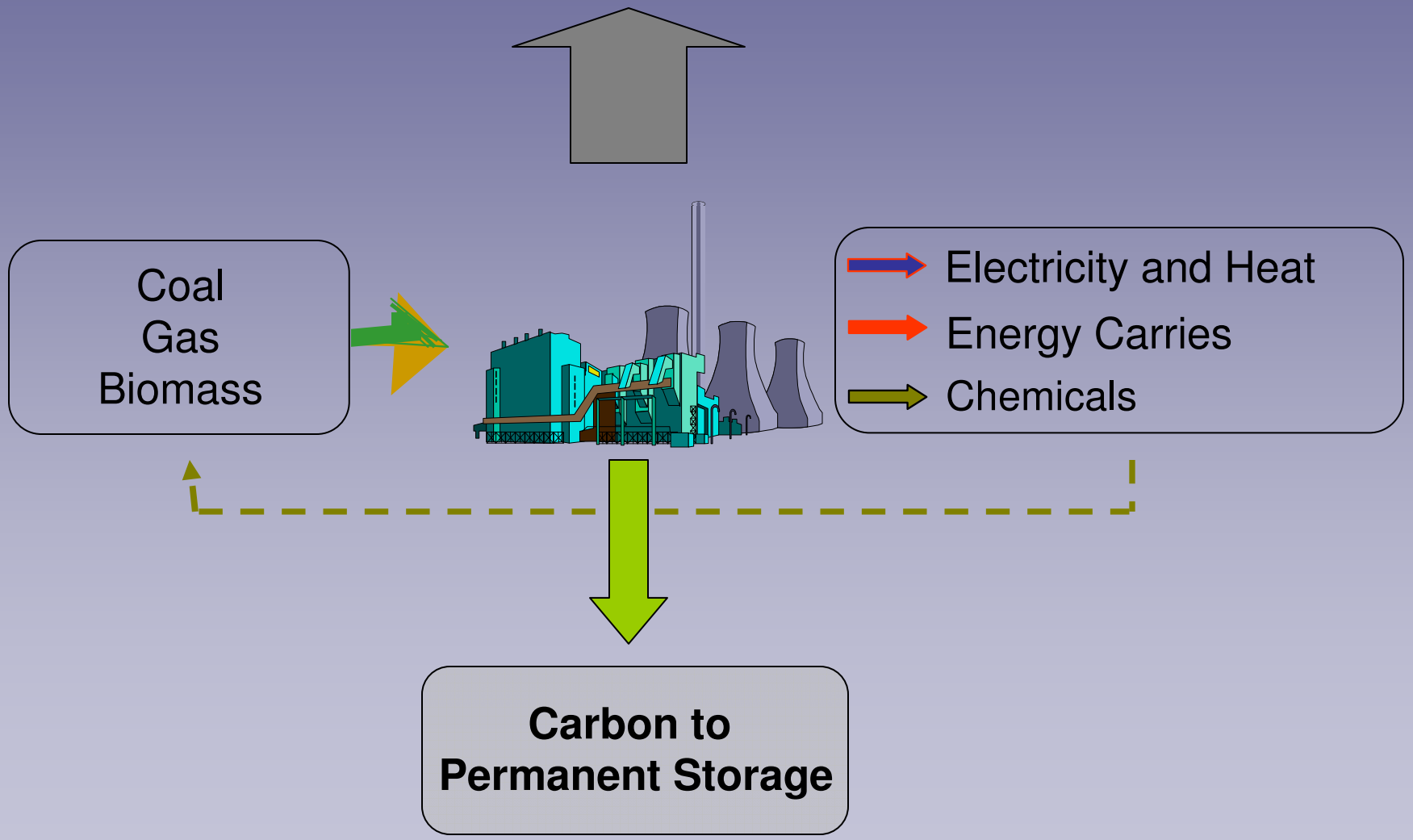


IIASA

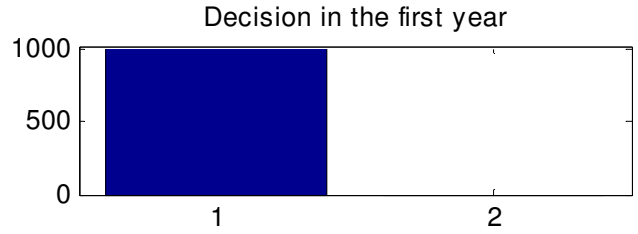
Forestry Program

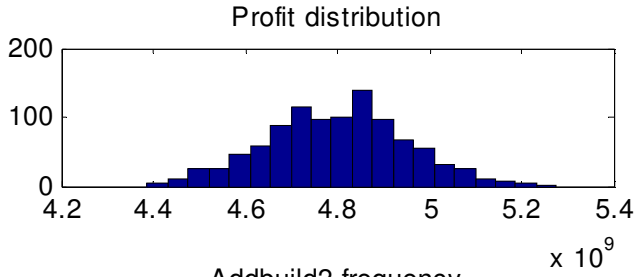
Power Plant Optimization under Uncertain Weather and Climate

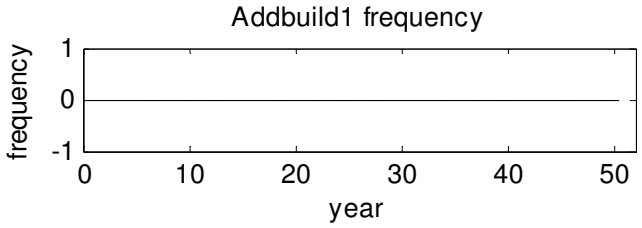
Carbon Dioxide

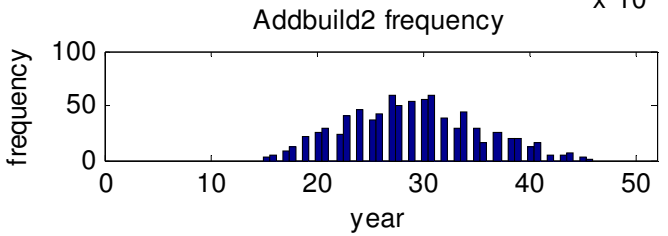


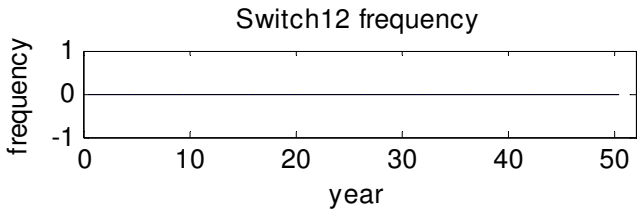
Results #1

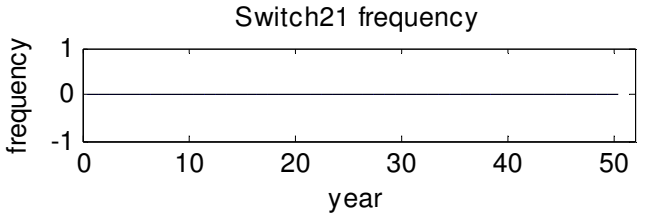

Decision in the first year
1000
500
0
1
2

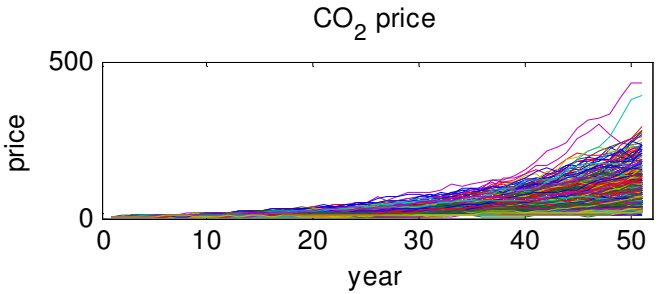

Profit distribution
200
100
0
4.2
4.4
4.6
4.8
5
5.2
5.4
x 10^9

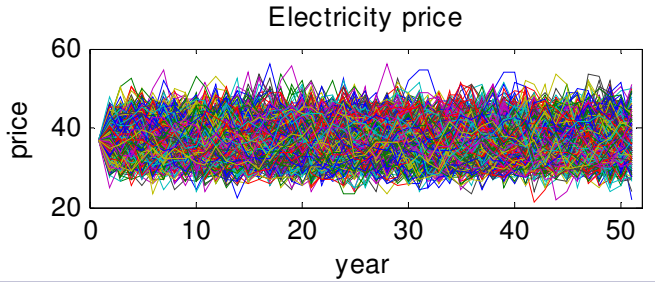

Addbuild1 frequency
frequency
1
0
-1
0
10
20
30
40
50
year


Addbuild2 frequency
frequency
100
50
0
0
10
20
30
40
50
year

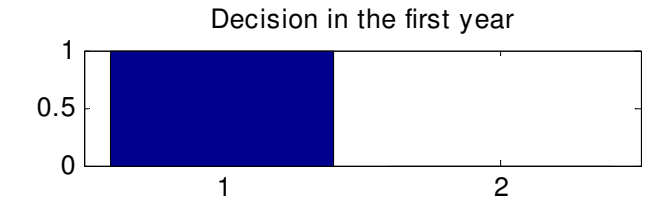

Switch12 frequency
frequency
1
0
-1
0
10
20
30
40
50
year

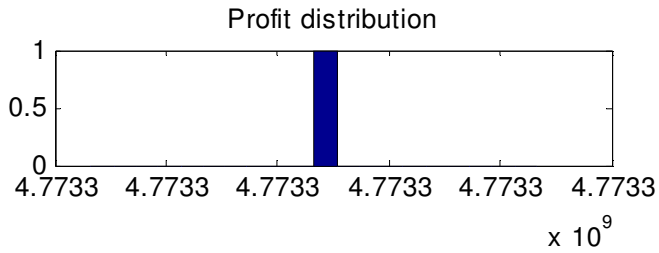

Switch21 frequency
frequency
1
0
-1
0
10
20
30
40
50
year

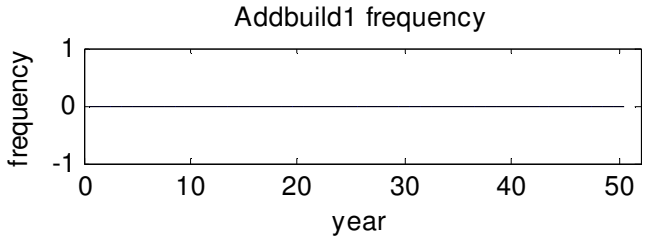

CO2 price
price
500
0
0
10
20
30
40
50
year

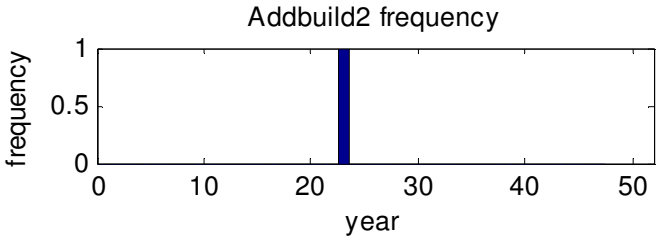

Electricity price
price
60
40
20
0
10
20
30
40
50
year

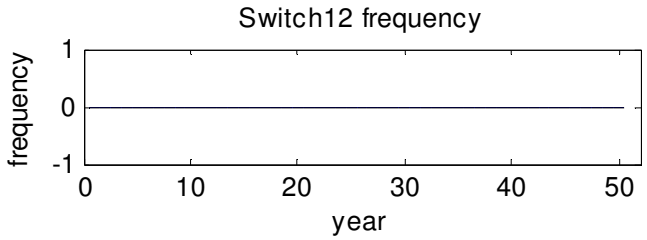
Results #2

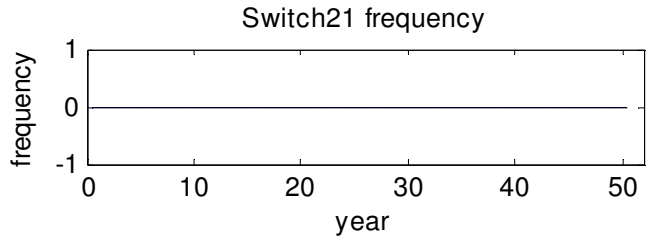

Decision in the first year
1
0.5
0
1
2

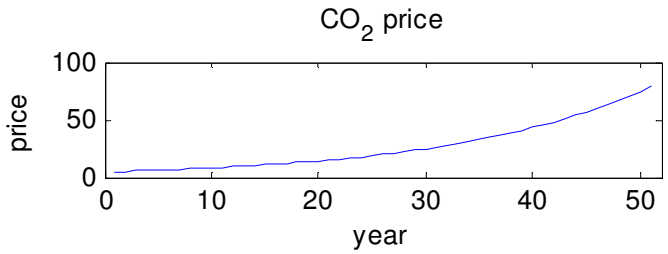

Profit distribution
1
0.5
0
4.7733
4.7733
4.7733
4.7733
4.7733
4.7733
x 10^9

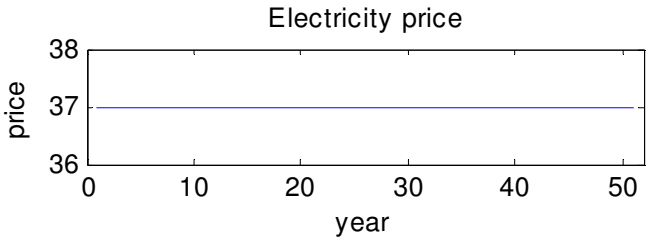

Addbuild1 frequency
frequency
1
0
-1
0
10
20
30
40
50
year


Addbuild2 frequency
frequency
1
0.5
0
0
10
20
30
40
50
year

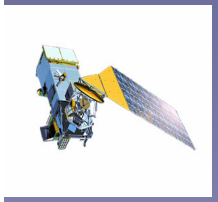

Switch12 frequency
frequency
1
0
-1
0
10
20
30
40
50
year


Switch21 frequency
frequency
1
0
-1
0
10
20
30
40
50
year

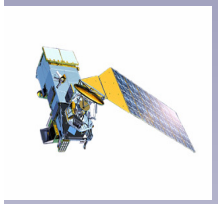

CO2 price
price
100
50
0
0
10
20
30
40
50
year


Electricity price
price
38
37
36
0
10
20
30
40
50
year

What Does Research Provide?

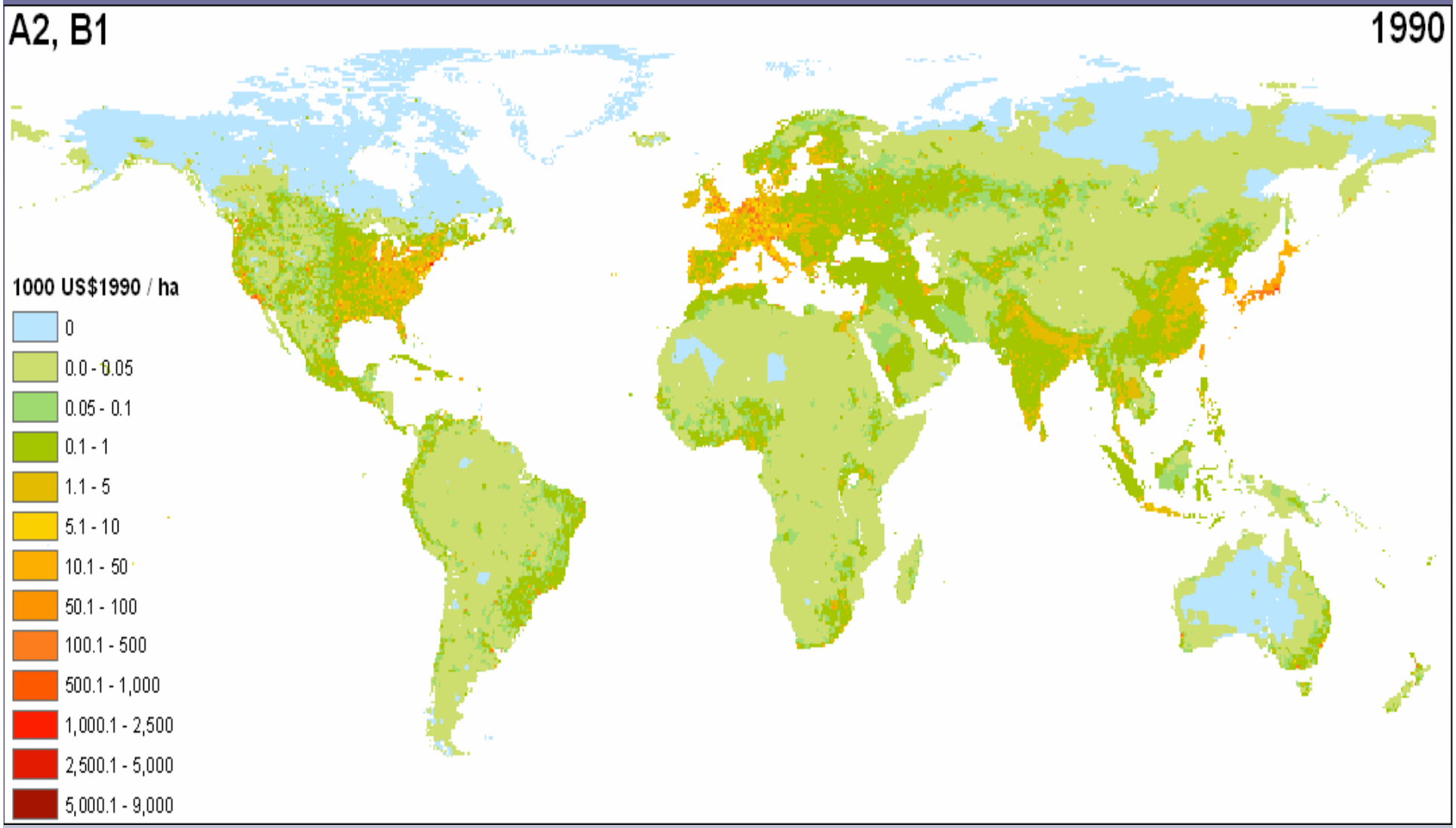


- **Earth System Models**
  - **Daily data**
  - **Precise vegetation and soil information**
  - **Socialize the pixel (e.g., field size)**



- **Pixelize the Social**
  - **Current Management**
  - **Ownership**
  - **Siesta hours, etc.**

Case: Pixelize the Social



Final Points from Space Economics

- Economies of Scope (Benefits)/Smoke Pipes (Cost) — GEO IDE
- Market Model — Data Stewardship
  - Government
  - Commercial
  - Academic
- Model (Decision) — Observation/Data Fusion Concept

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