30-year Change of Natural Forests under Human Activities in the Indochina Peninsula – Case studies in Laos, Cambodia and Vietnam

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Outline

- Introduction
- Indochina peninsula and needs for natural forest monitoring
- Landsat time series image data and automated classification of natural forest
- 30-year change of natural forests under human activities in Attapeu (Laos), Ratanakiri (Cambodia) and Kontum (Vietnam)
- Results and discussion
- Conclusions and next steps

Introduction

- Natural forests are one of the most basic components of the earth environment
- A natural forest (NF) is a generally multilayered vegetation unit dominated by trees (largely evergreen or semi-deciduous), whose combined strata have overlapping crowns (DAFF).
- Natural forests in South East Asia and Indochina peninsula are rich on species and provide important ecological, environment protection, and economic functions.

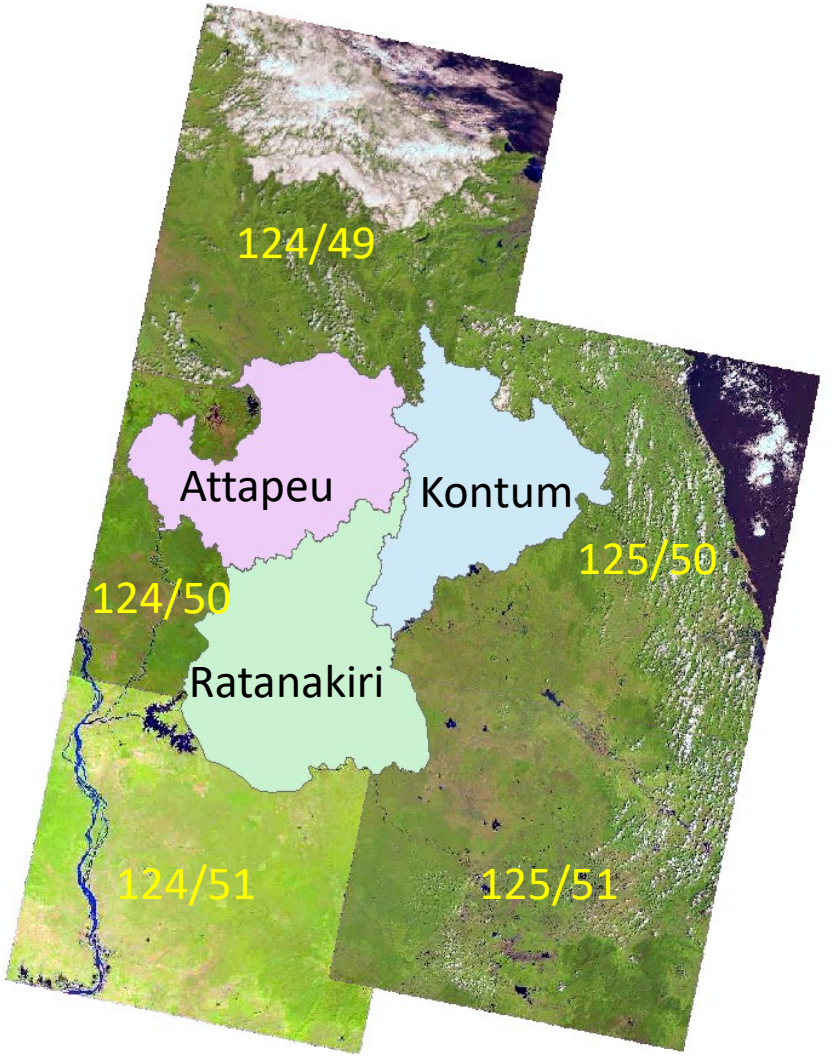
- Estimates of tropical natural forests are challenging and still contain considerable uncertainties.
- Natural forests are interfered by human activities in a number of ways: by logging and conversion to cropland, commodity trees and development of land.
- Detection of natural forest disturbance and its temporal monitoring by earth observation is urgent need. However, it is a complex task because it requires special techniques which allow reliable differentiation of natural forests and planted forests.
- In this study, we present a preliminary results on application of Landsat image data from 1989 to 2018 to study change of natural forest cover in Indochina peninsula with focus on provinces Attapeu (Laos), Ratanakiri (Cambodia), and Kontum (Vietnam).

Indochina Peninsula and Needs of Natural Forest Monitoring

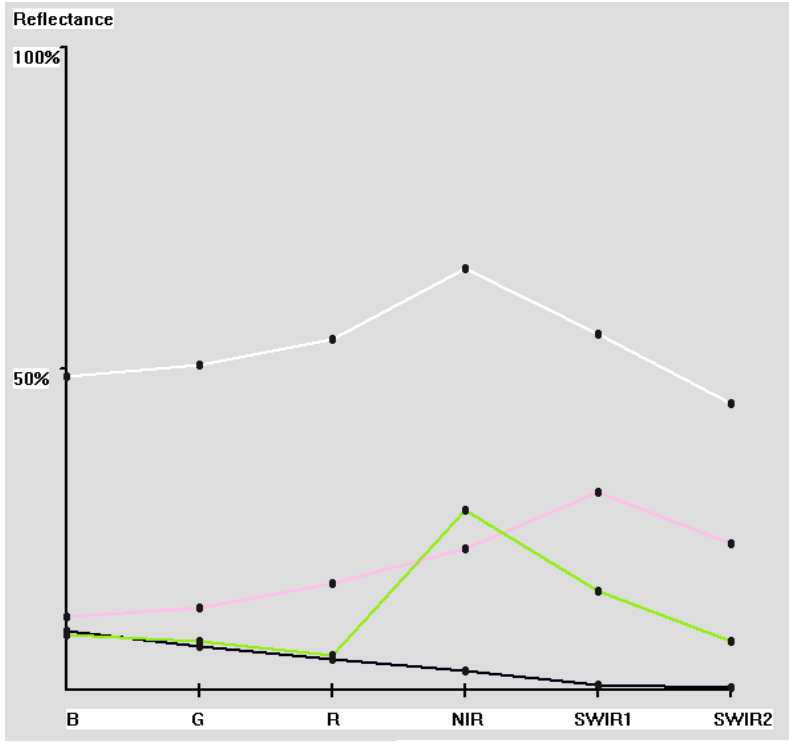
- Indochina peninsula is composed of 6 countries: Myanmar, Thailand, Malaysia, Laos, Cambodia, and Vietnam
- Study area selected in this research involves three provinces Attapeu (Laos), Ratanakiri (Cambodia), and Kontum (Vietnam).
- The selected provinces located in three countries which have different system in forest ownership and land policies are ideal for study of institutional factors in deforestation process.

Landsat time series image data and automated classification of natural forest

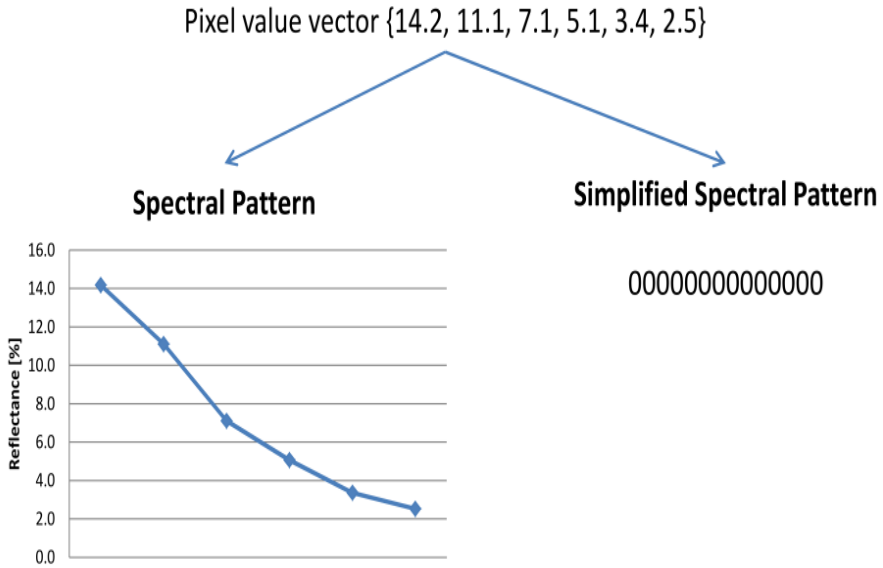
- The study area is covered by 5 Landsat scenes with path/row numbers: 124/49, 124/50, 124/51, 125/50, and 125/51
- About 500 Landsat scenes of Collection 1 Level-1 of sensors TM, ETM+ and OLI since 1988 was downloaded from USGS website https://earthexplorer.usgs.gov/
- Before analysis, all Landsat image data were converted to top of atmosphere reflectance (TOA).
- Information of cloud and cloud shadow in BQA channel was used for cloud and cloud shadow detection.



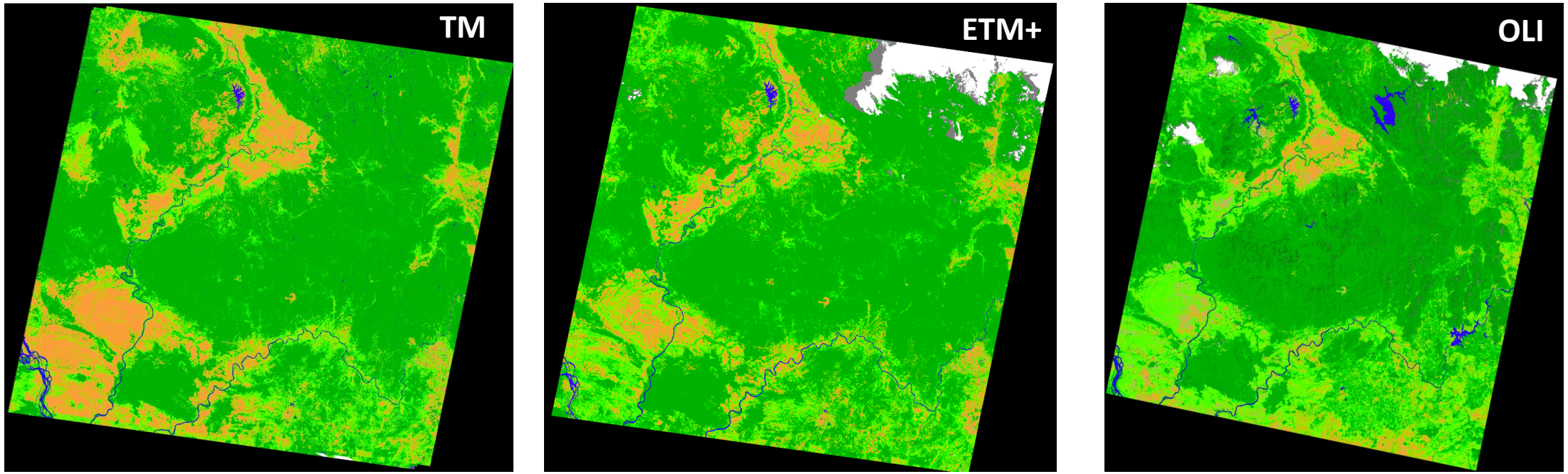
- Spectral pattern analysis method was used for classification of land cover.
- In this method, each land cover class is defined by a shape of spectral pattern composed of the 6 spectral band values of TM, ETM+ and OLI.
- The shape of spectral pattern defined by a simplified spectral pattern consisted of 15 digits including: 0, 1, 2.
- The simplified spectral pattern (SSP) is constructed by non-repetitive pairwise comparison of reflectance values between two spectral bands.



- White: Cloud
- Pink: Bare land
- Green: Vegetation
- Black: Water

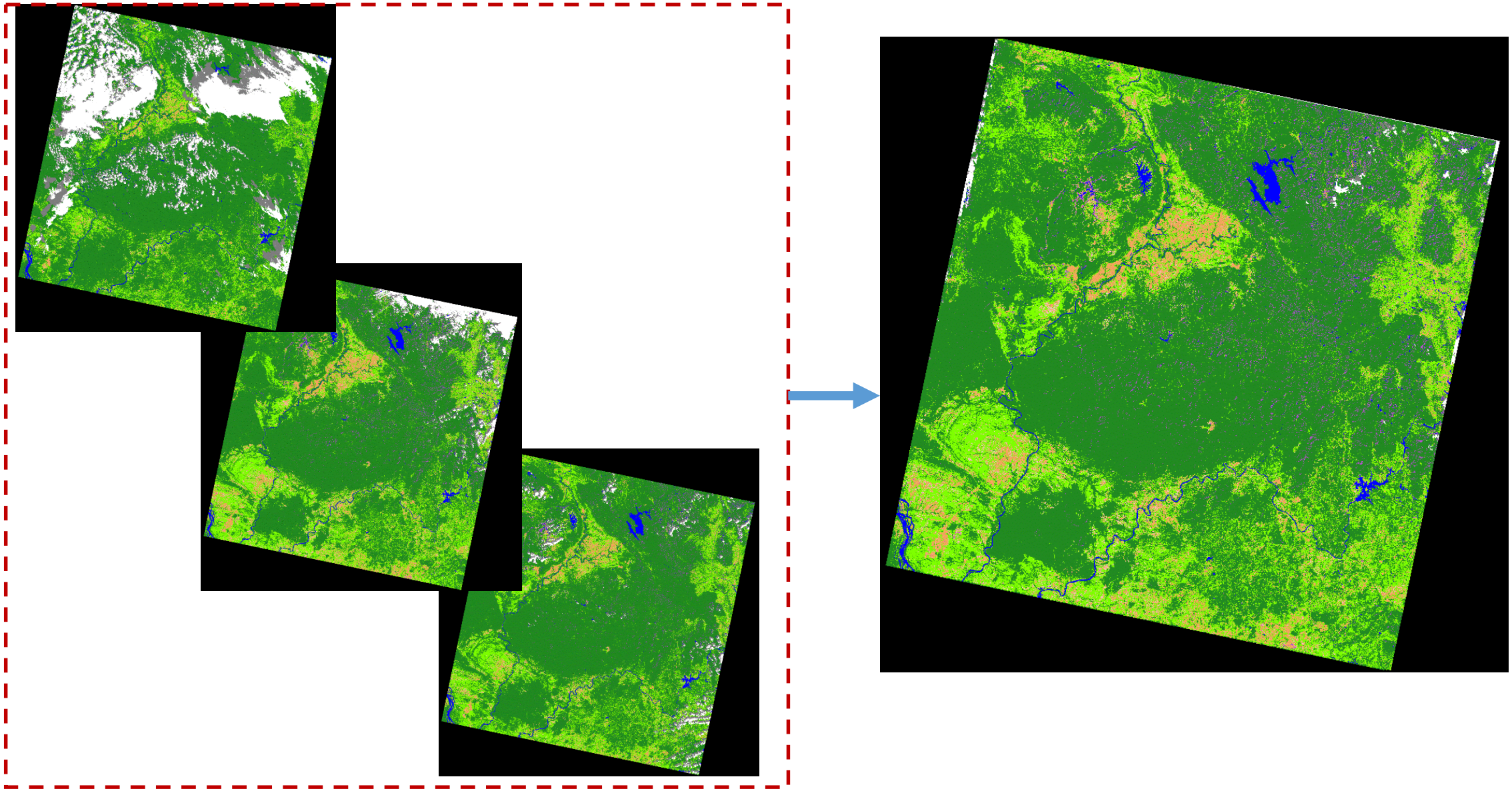


- We developed three databases of spectral patterns together with classification rules for Landsat sensors TM, ETM+ and OLI for basic land cover classes: Cloud, cloud shadow, water, wetland, closed forest, open forest and bare land



Examples of land cover maps classified by spectral pattern analysis based method

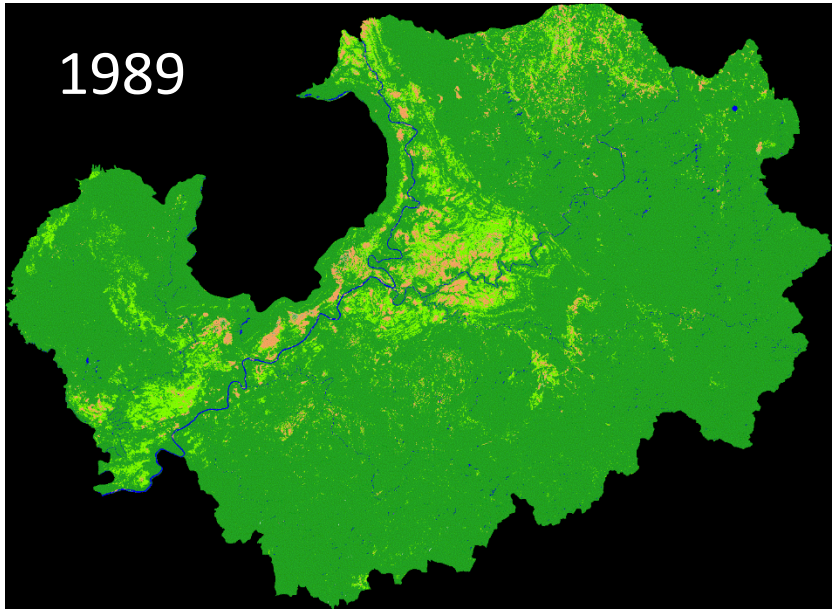
Examples of image stacking to create cloud free classified image

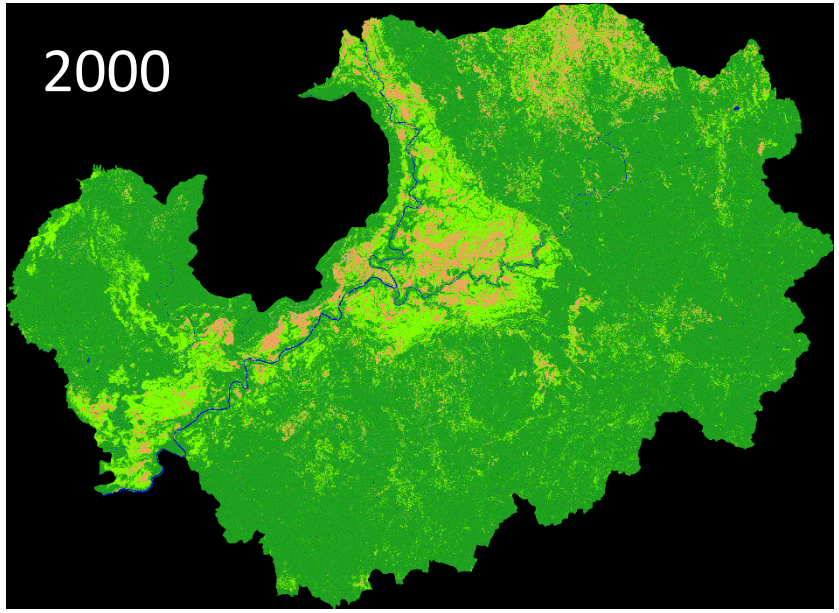


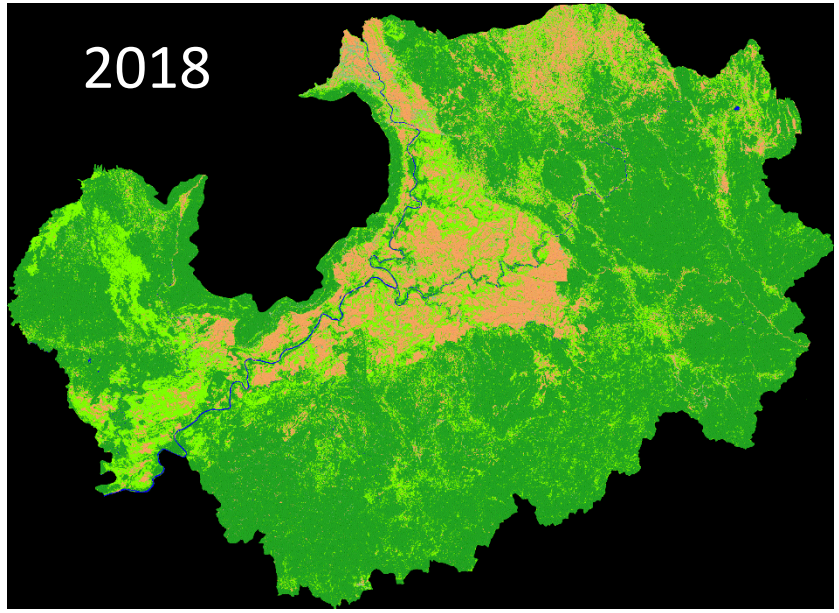
- Natural forests are disturbed by major forms as:
  - Timber logging and illegal selective logging
  - Shifting cultivation
  - Change to other plantation
  - Hydropower plant development, mining and road construction

Results and Discussions

Attapeu province

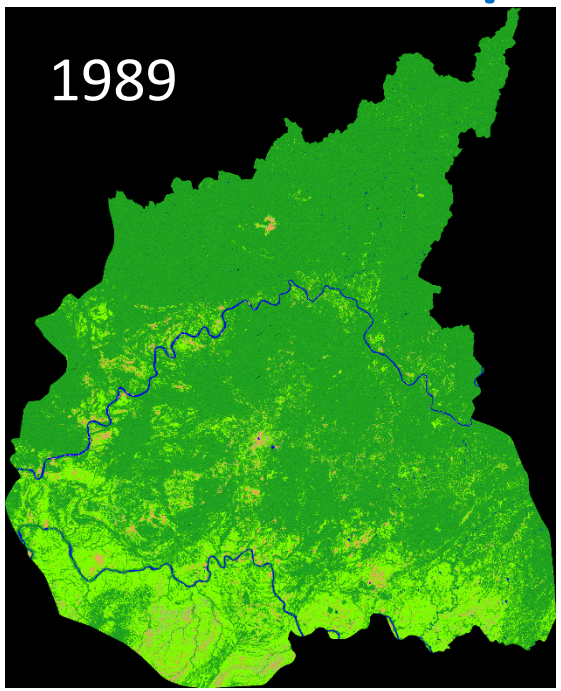


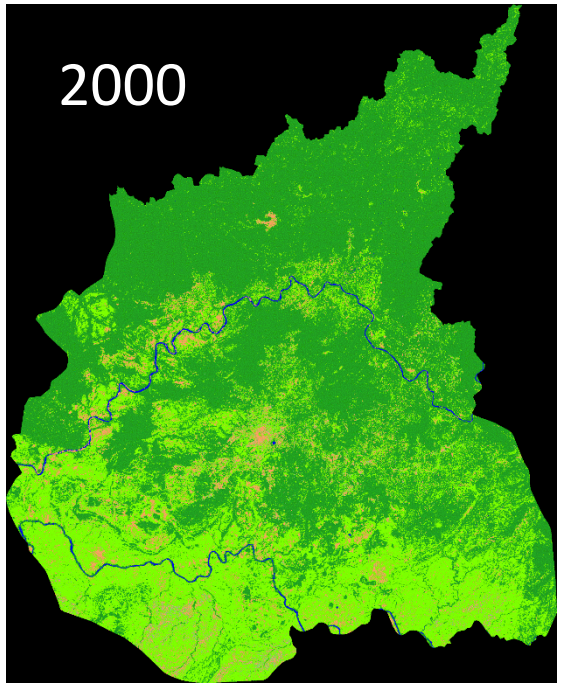


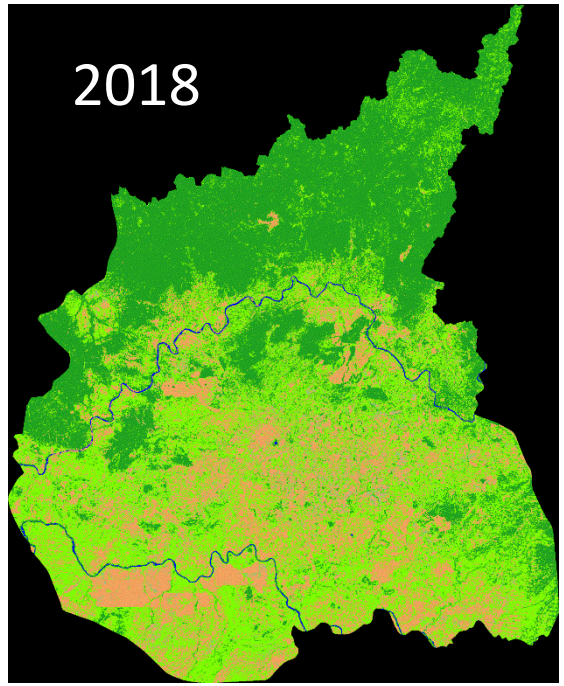


- Natural closed forest was reduced from 879,005 ha in 1989 to 634,557 ha in 2018 equivalent to loss of 27.8 % (annual 0.93 %)
- Natural open forest was increased from 90,752 ha in 1989 to 231,830 ha in 2018 equivalent to gain of 155.4 %.
- Area under intensive human activities increased from 23,957 ha in 1989 to 138,675 ha in 2018, equivalent to gain of 478.8 %.

Ratanakiri province

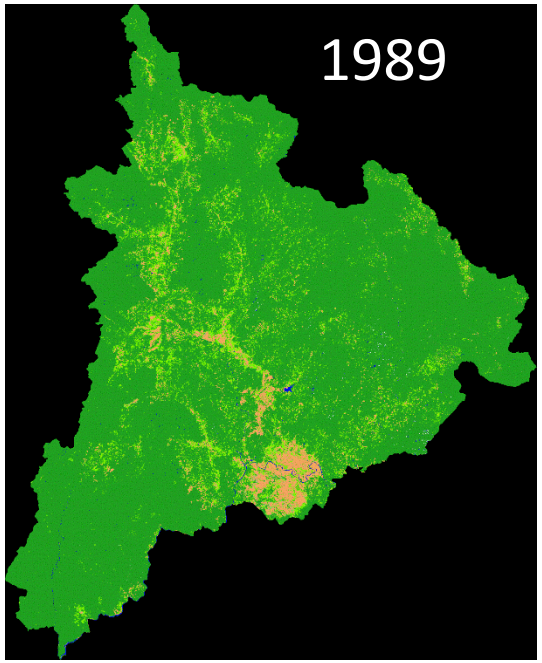


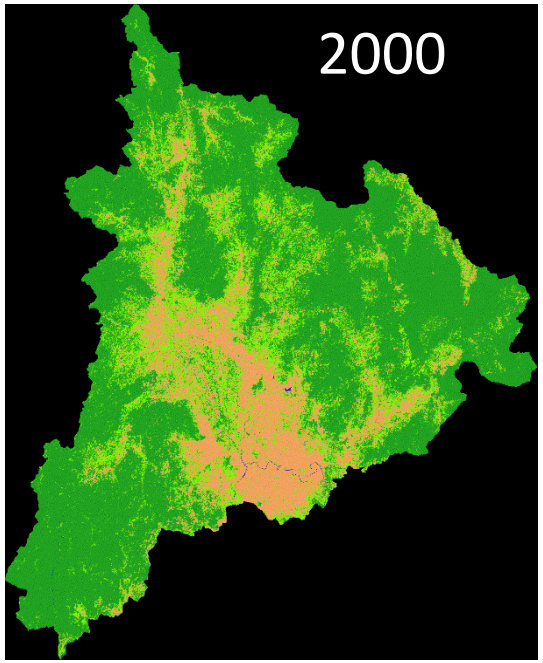


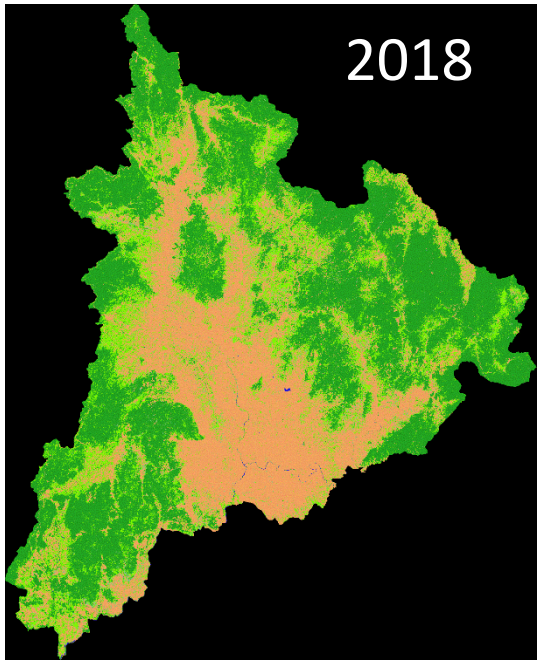


- Natural closed forest was reduced from 958,575 ha in 1989 to 466,529 ha in 2018 equivalent to loss of 51.3 % (annual 1.7 %)
- Natural open forest was increased from 277,796 ha in 1989 to 530,814 ha in 2018 equivalent to gain of 91.1%.
- Area under intensive human activities increased from 31,495 ha in 1989 to 273,830 ha in 2018, equivalent to gain of 769.4 %.

Kontum province







- Natural closed forest was reduced from 848,307 ha in 1989 to 424,388 ha in 2018 equivalent to loss of 50 % (annual 1.7 %)
- Natural open forest was increased from 78,629 ha in 1989 to 224,963 ha in 2018 equivalent to gain of 186.1 %.
- Area under intensive human activities increased from 40,098 ha in 1989 to 320,354 ha in 2018, equivalent to gain of 698.9 %.

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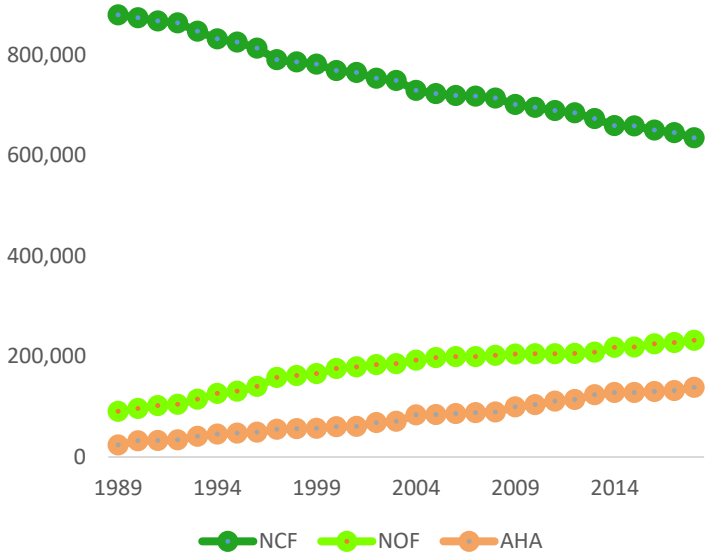

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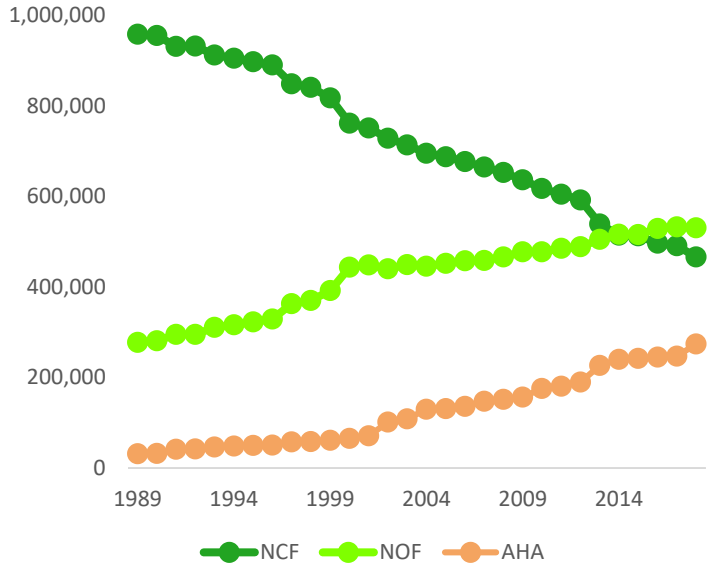

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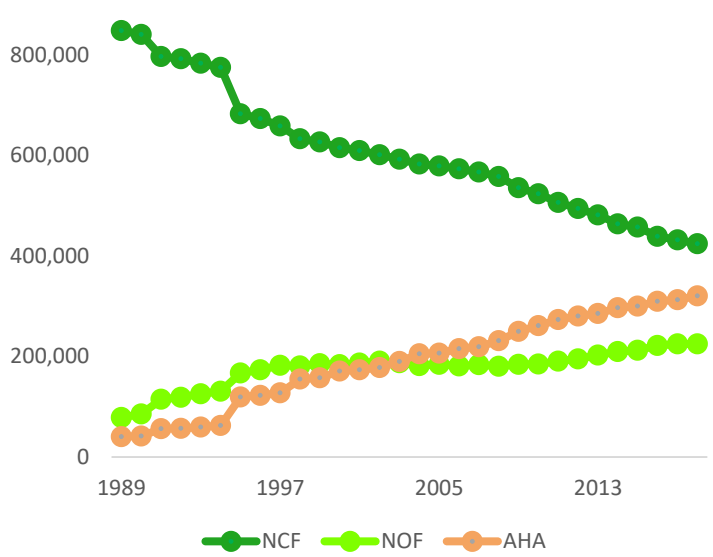
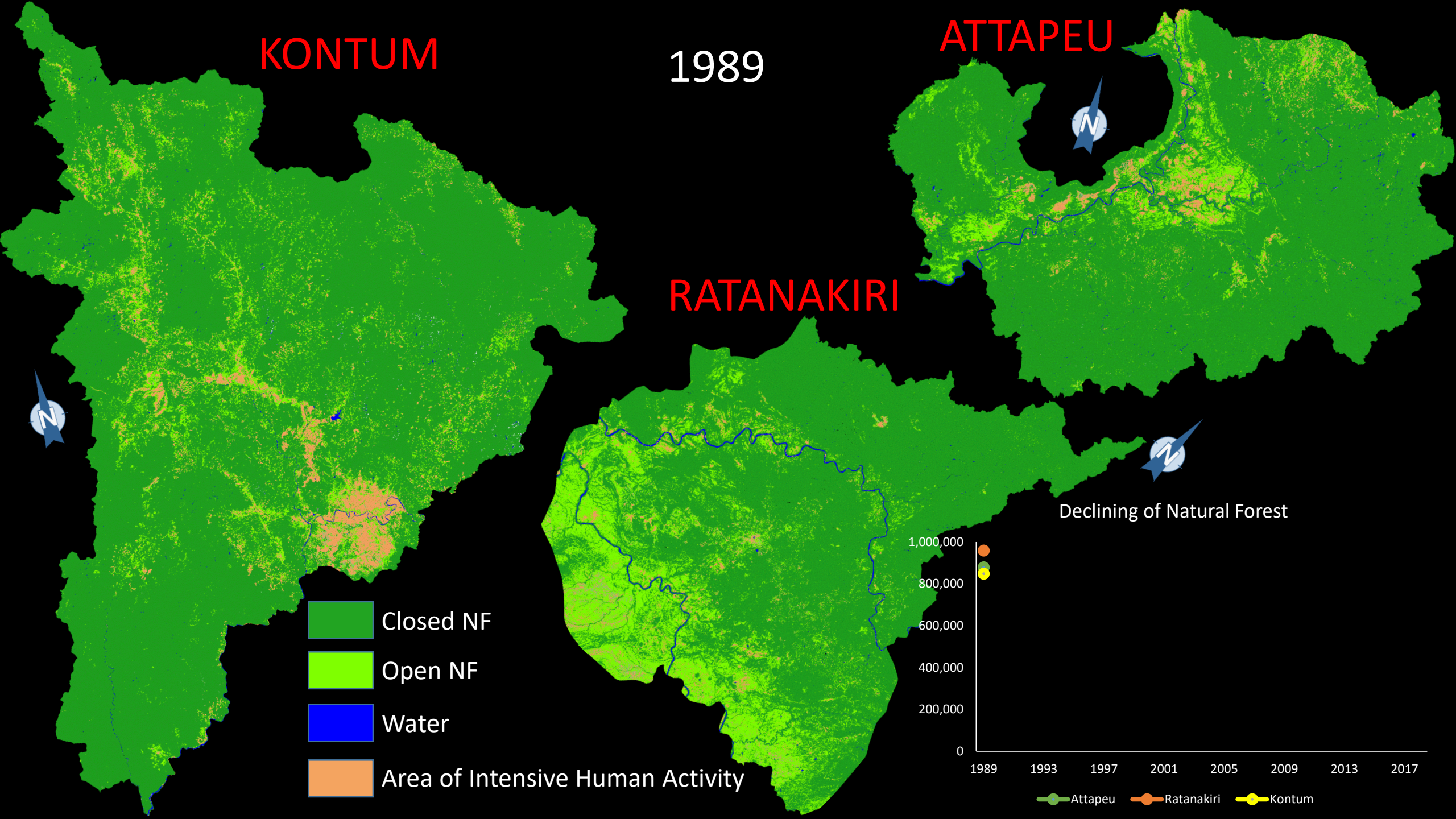


- These charts show 30-year changes of closed natural forest, open natural forest and areas under intensive human activities (AHA).
- Attapeu has gentle deforestation rate (0.9 %) and low conversion rate of forested land.
- Ratanakiri exhibits high deforestation rate (1.7 %) and medium conversion rate of forest land. Very high conversion rate of closed to open forest can be interpreted as high activities in timber logging.
- There is also high rate of deforestation (1.7 %) in Kontum. The change of closed forest to open forest was in alarming pace. Fast and steadily growing areas under intensive human activities manifests extensive land use in this province.

Next slides will show spatiotemporal change patterns of natural forests in the provinces during the course of 30 years from 1989 to 2018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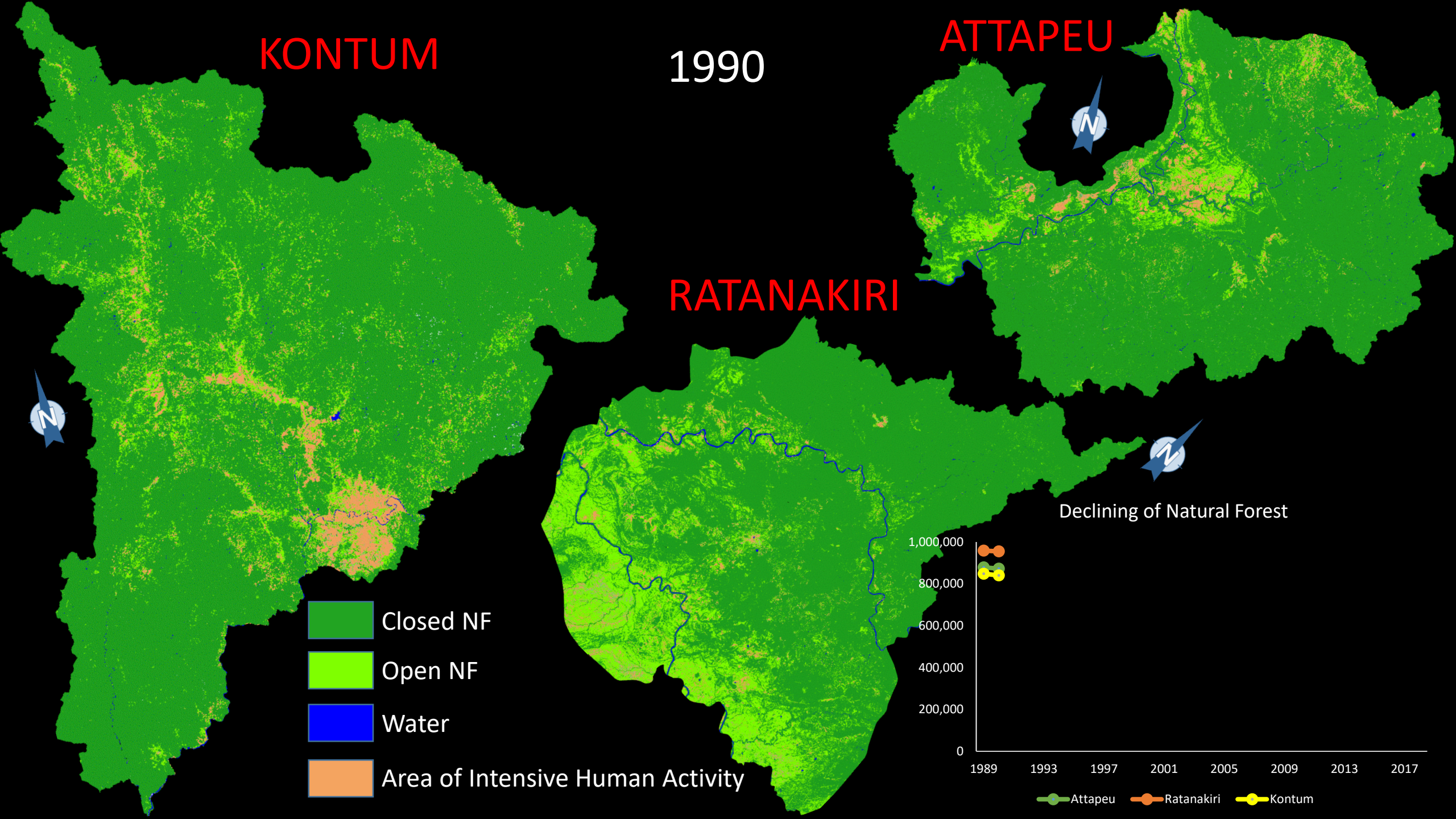
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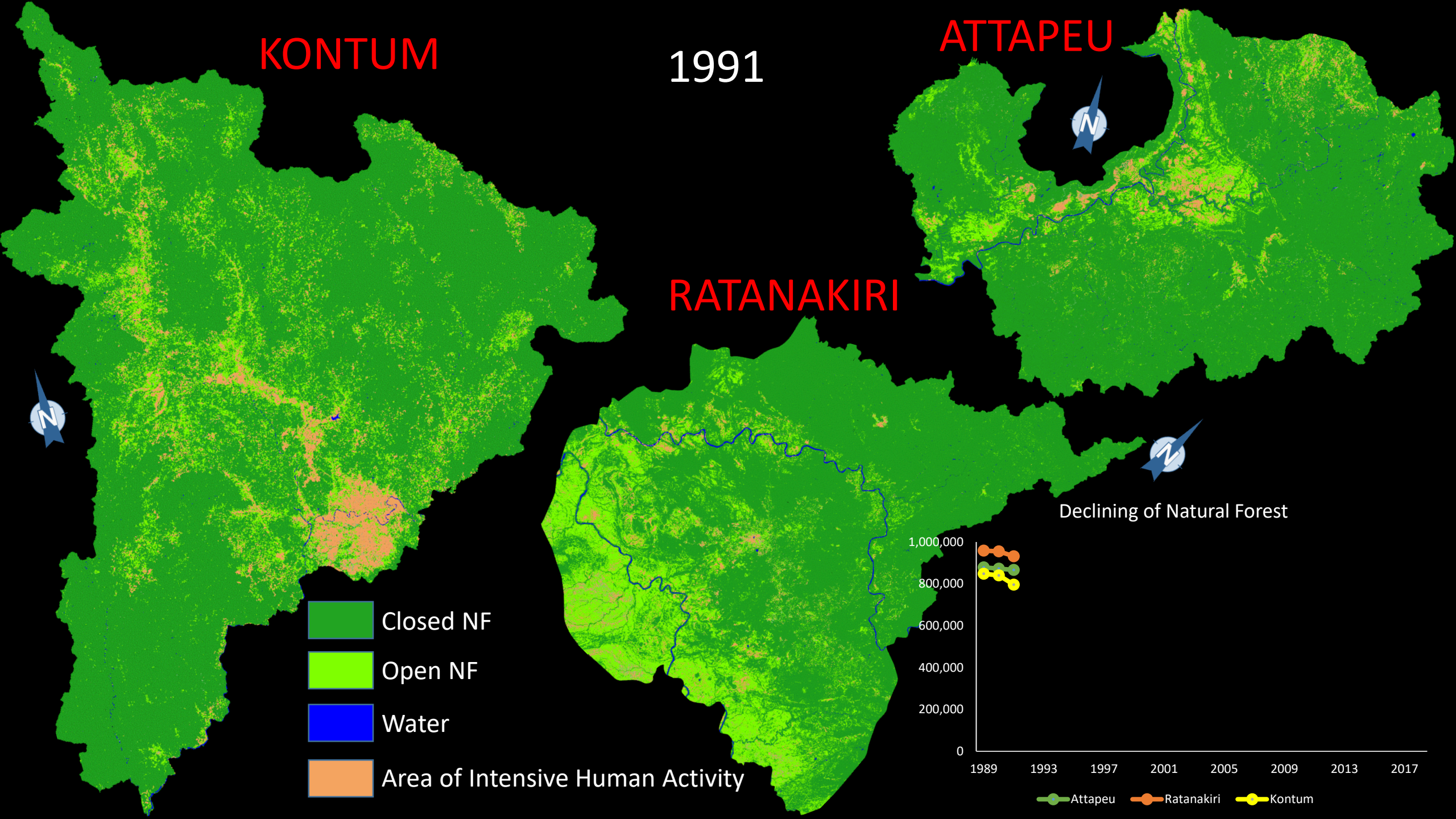
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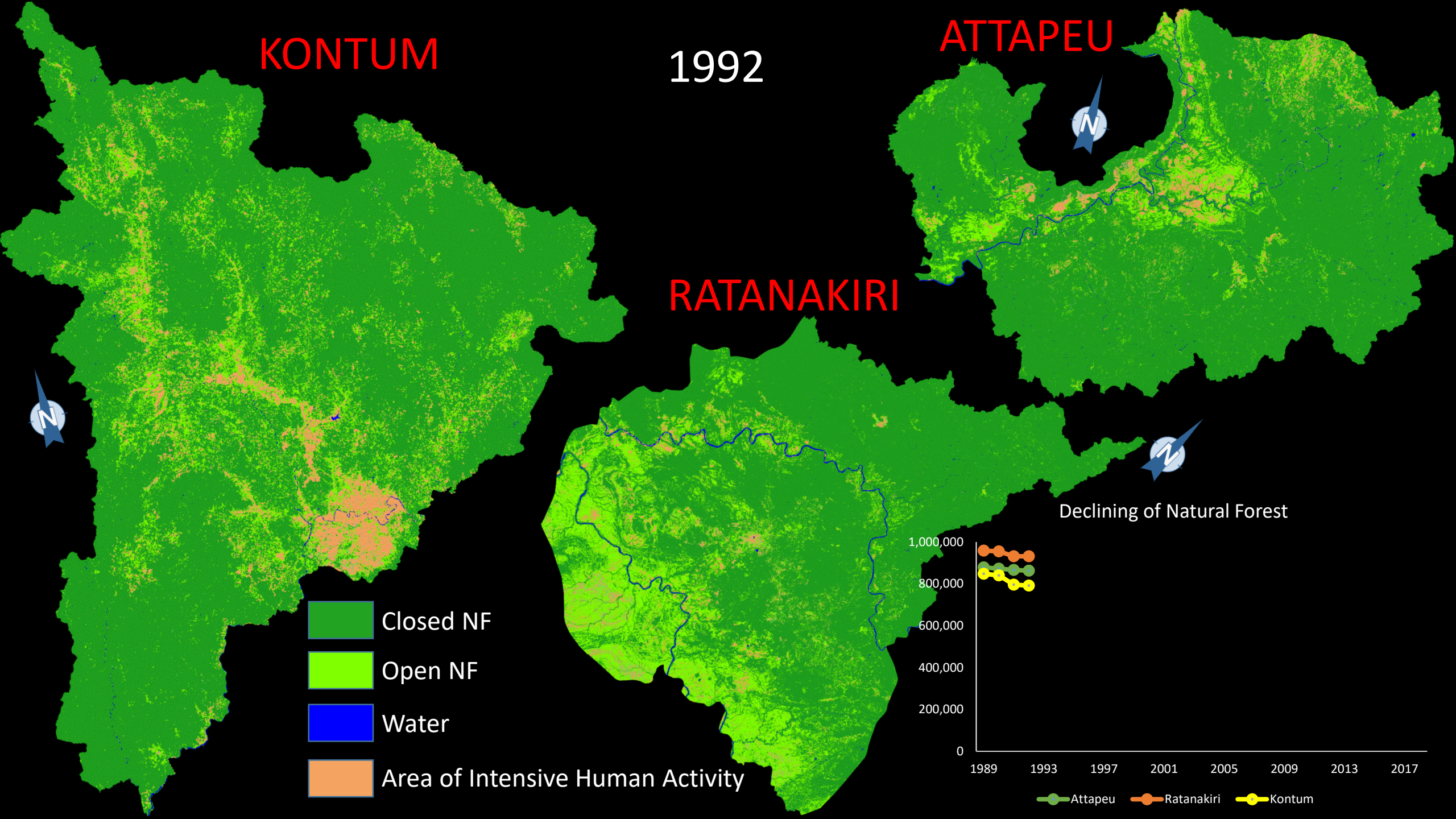
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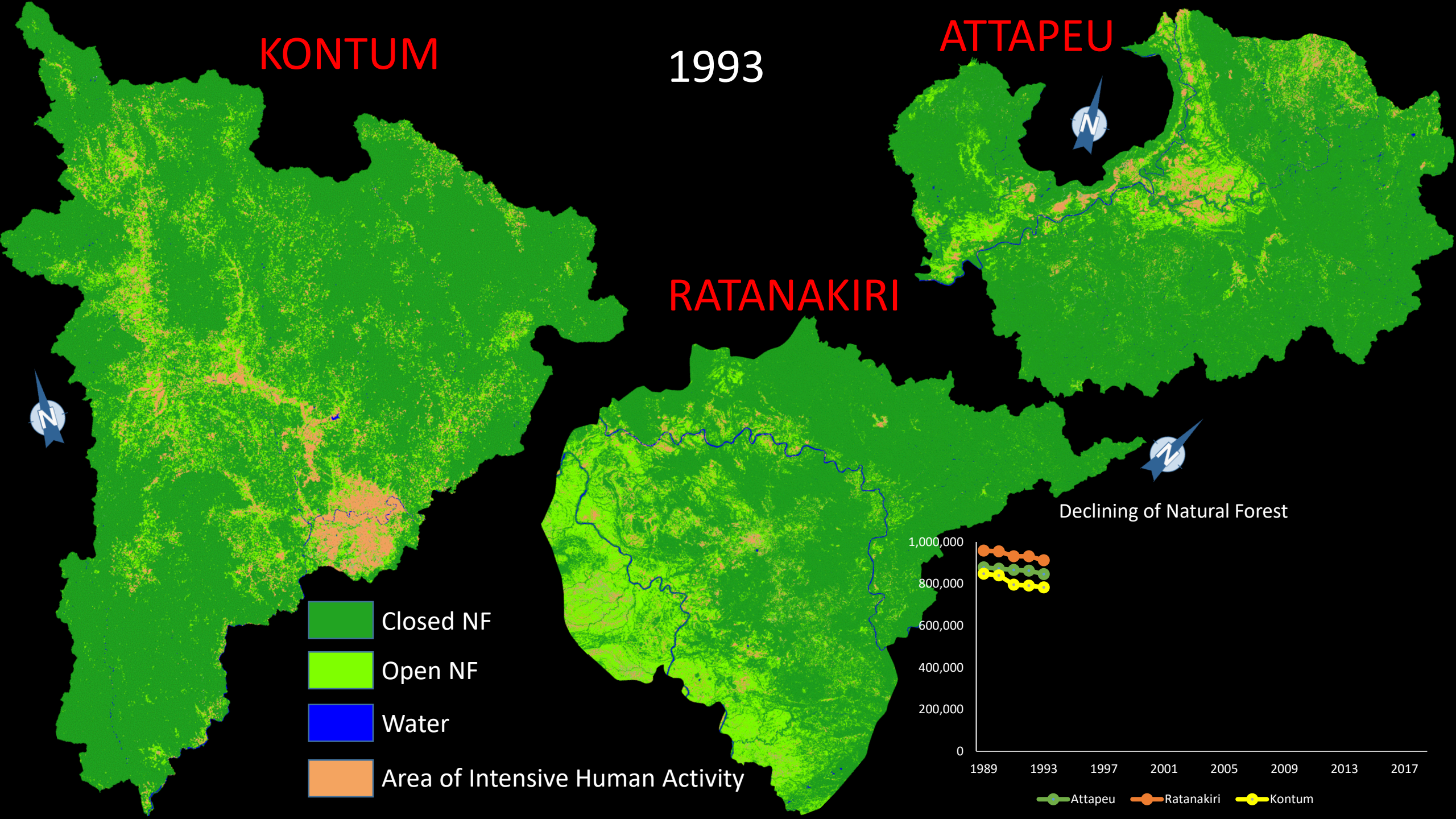
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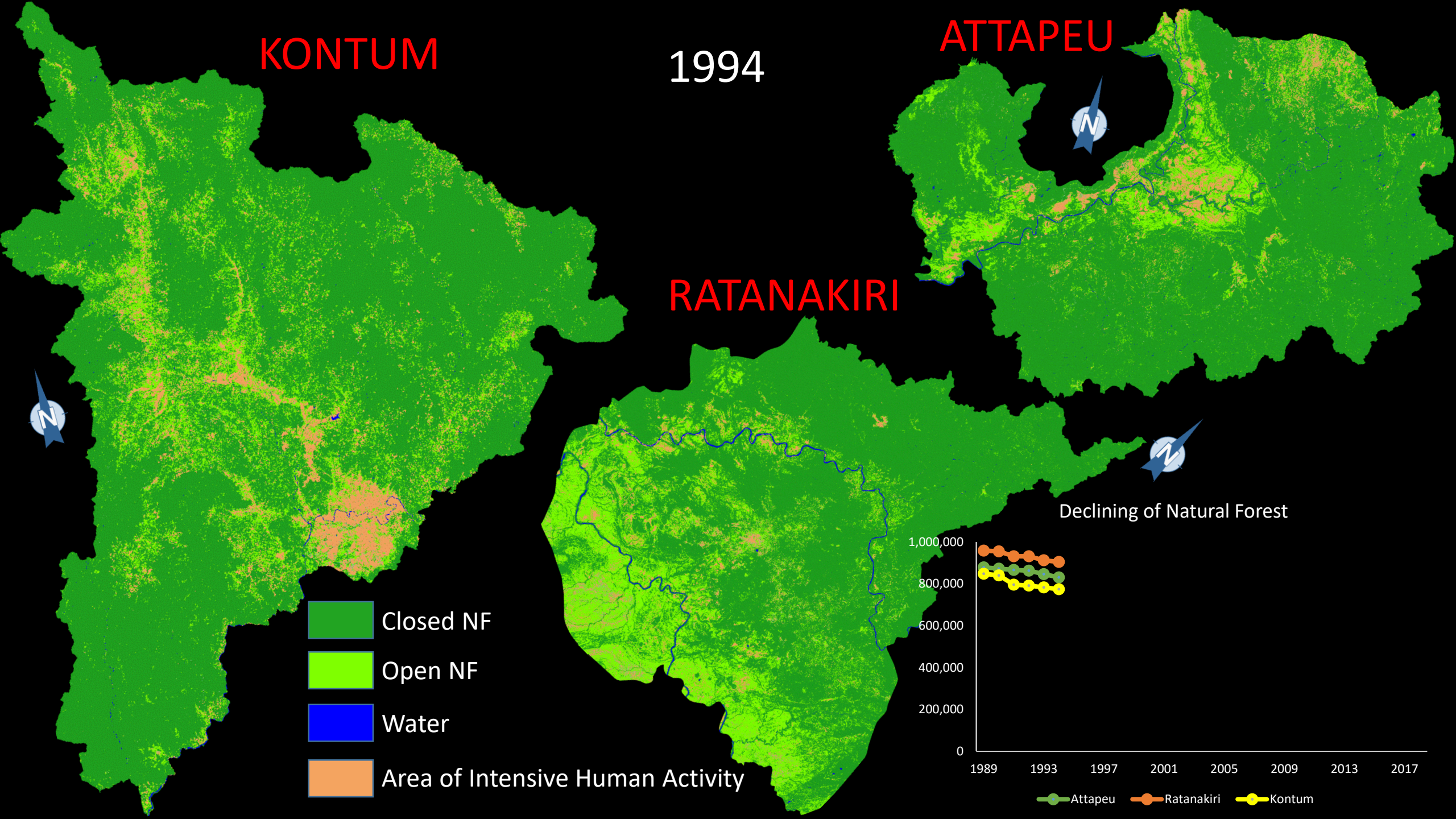
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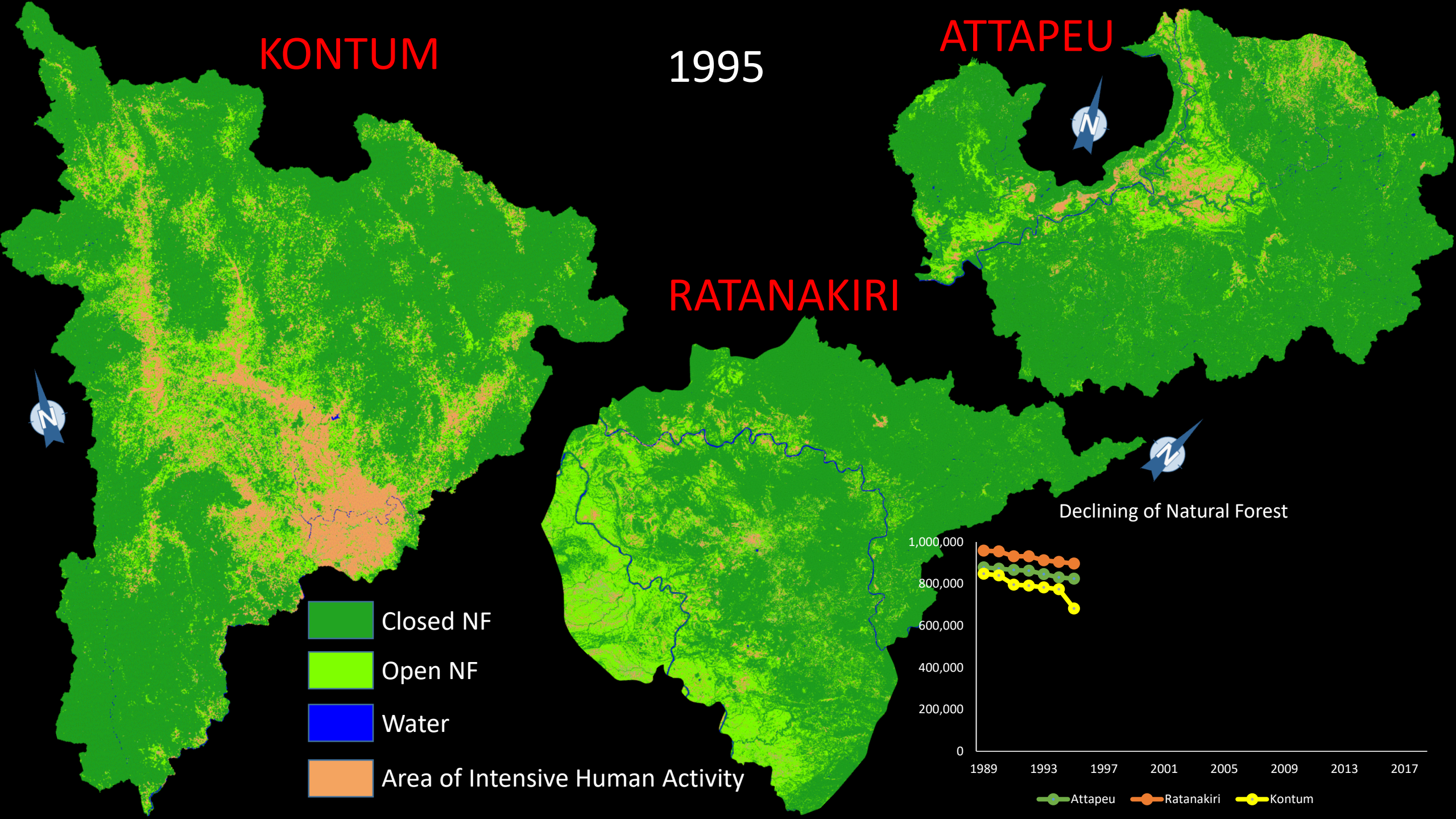
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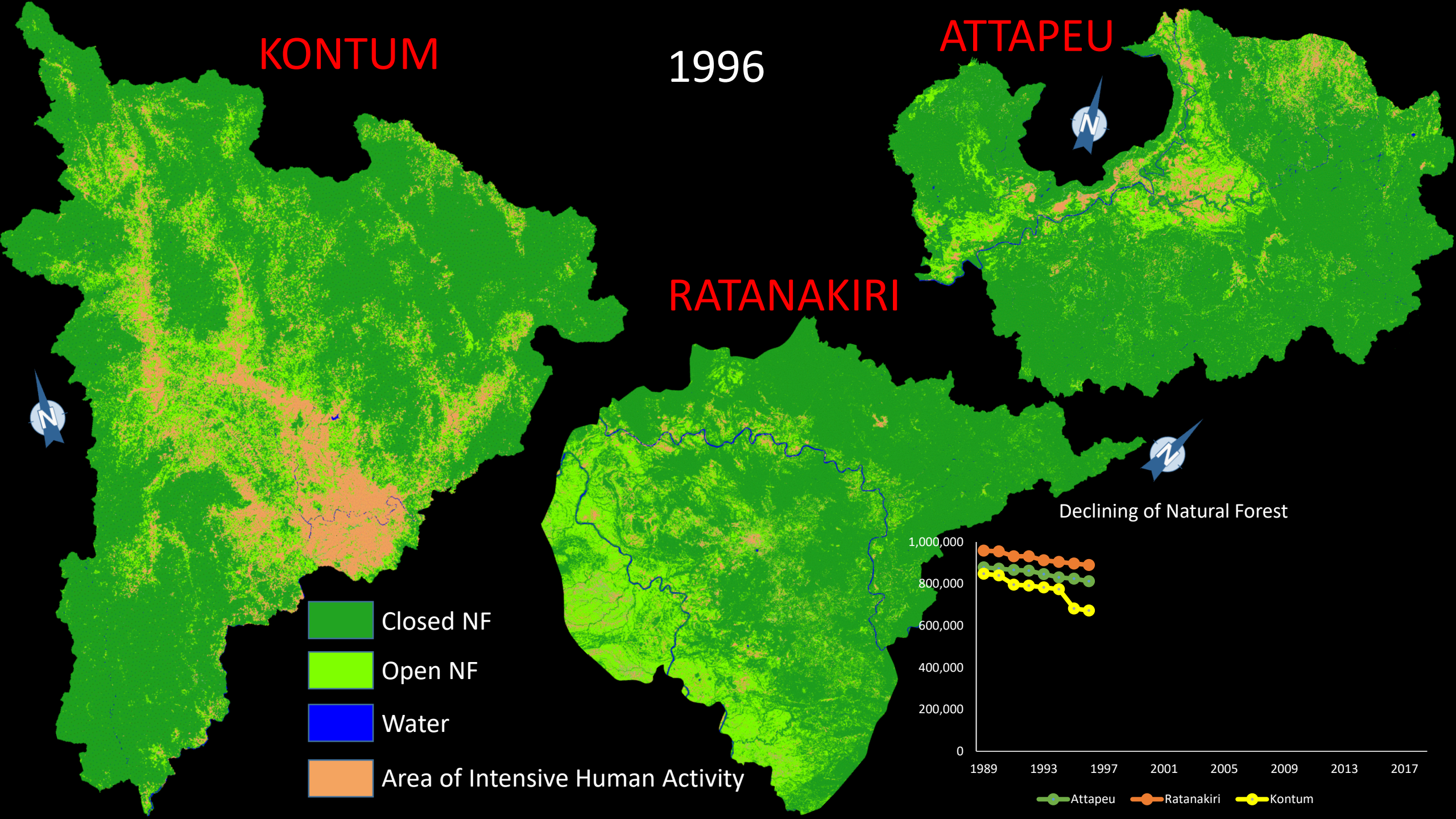
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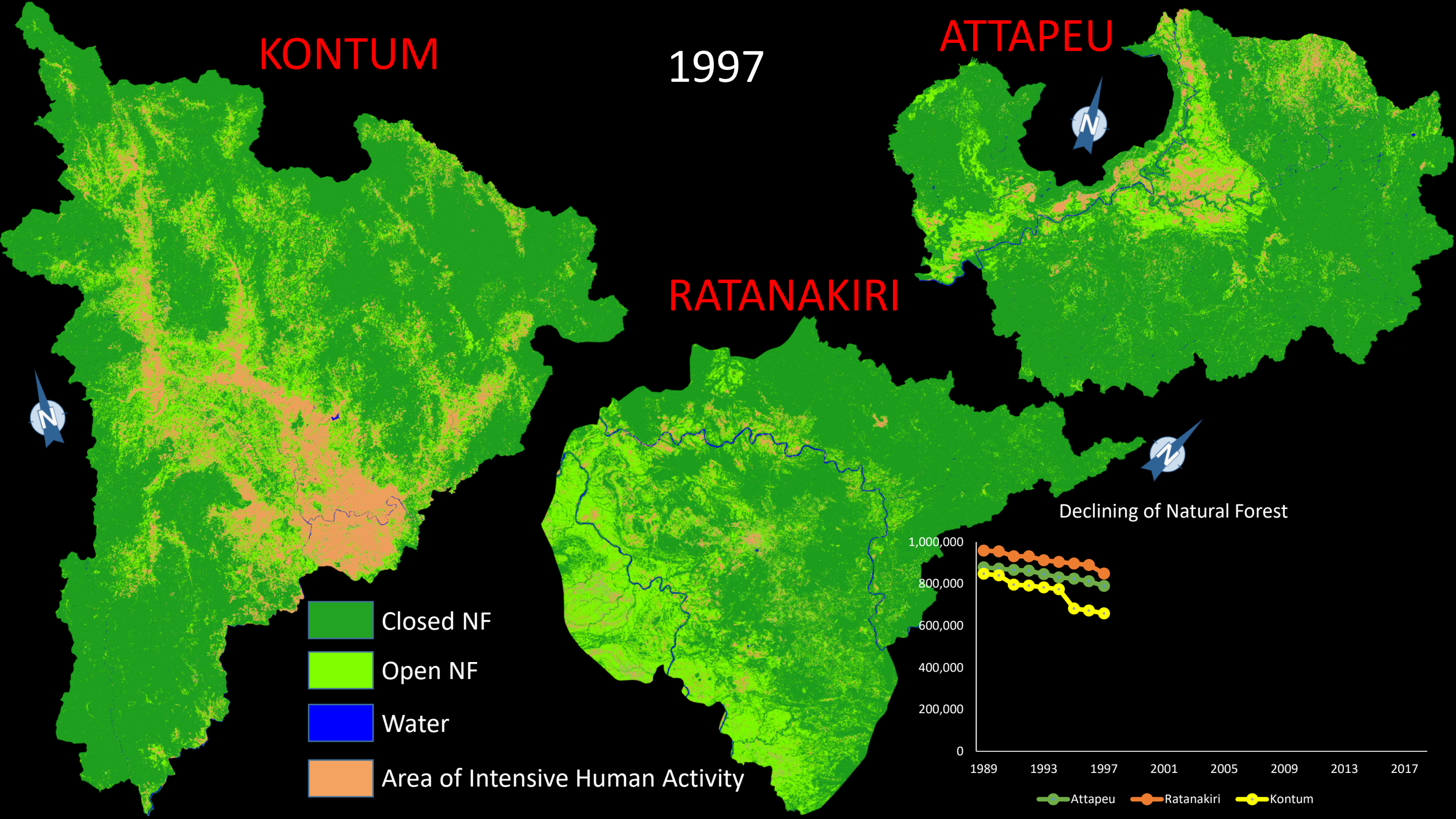
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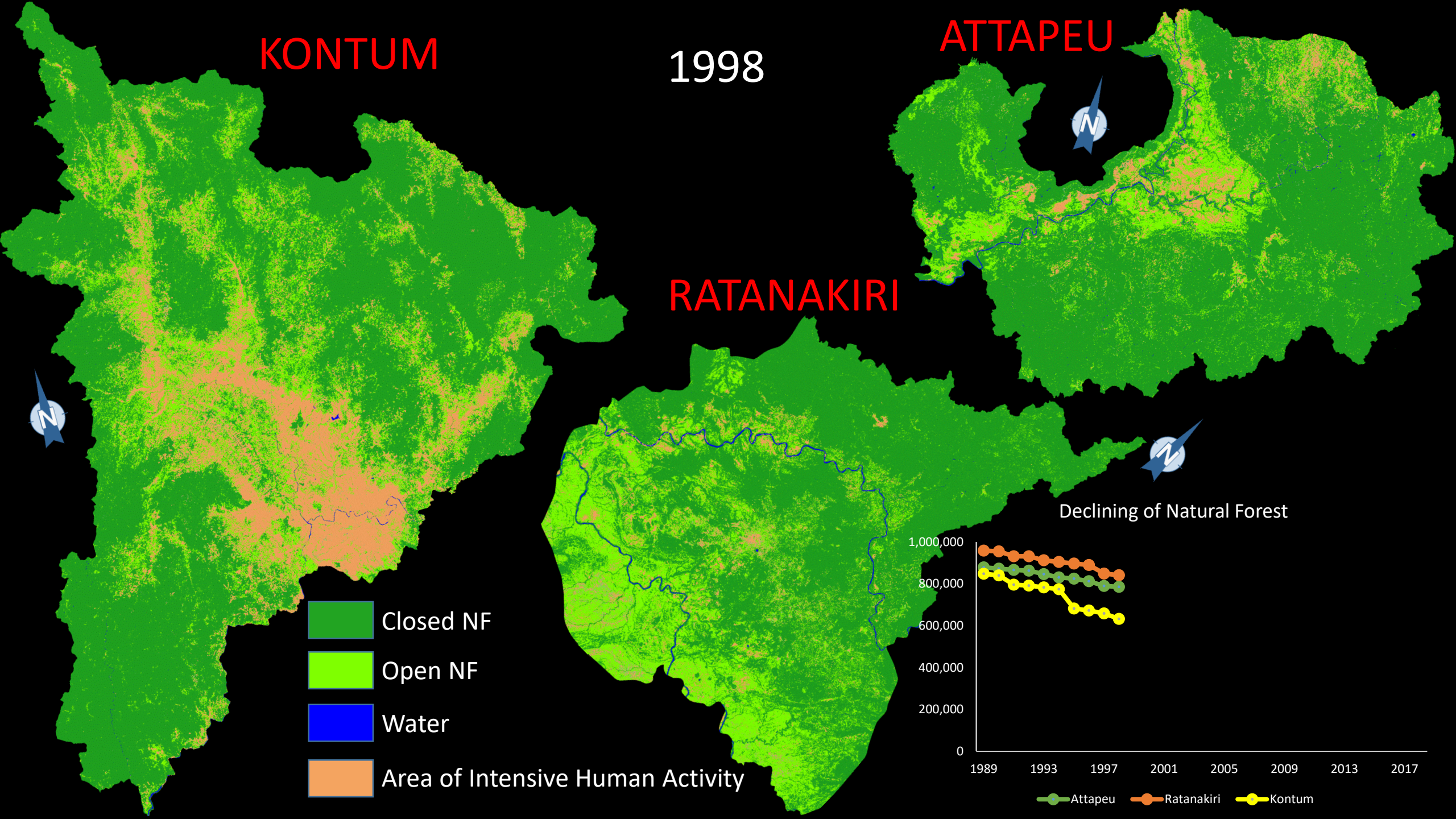
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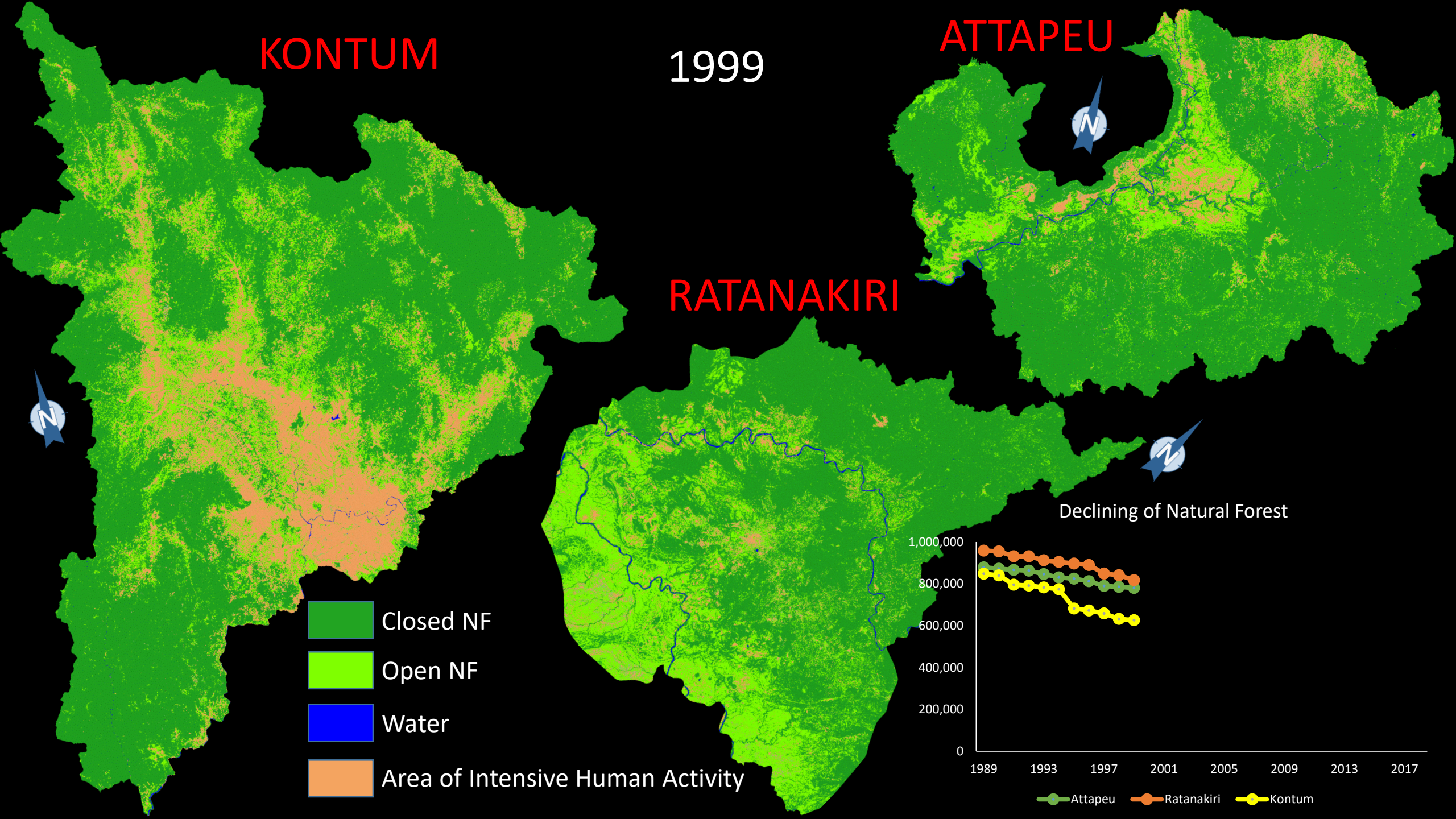
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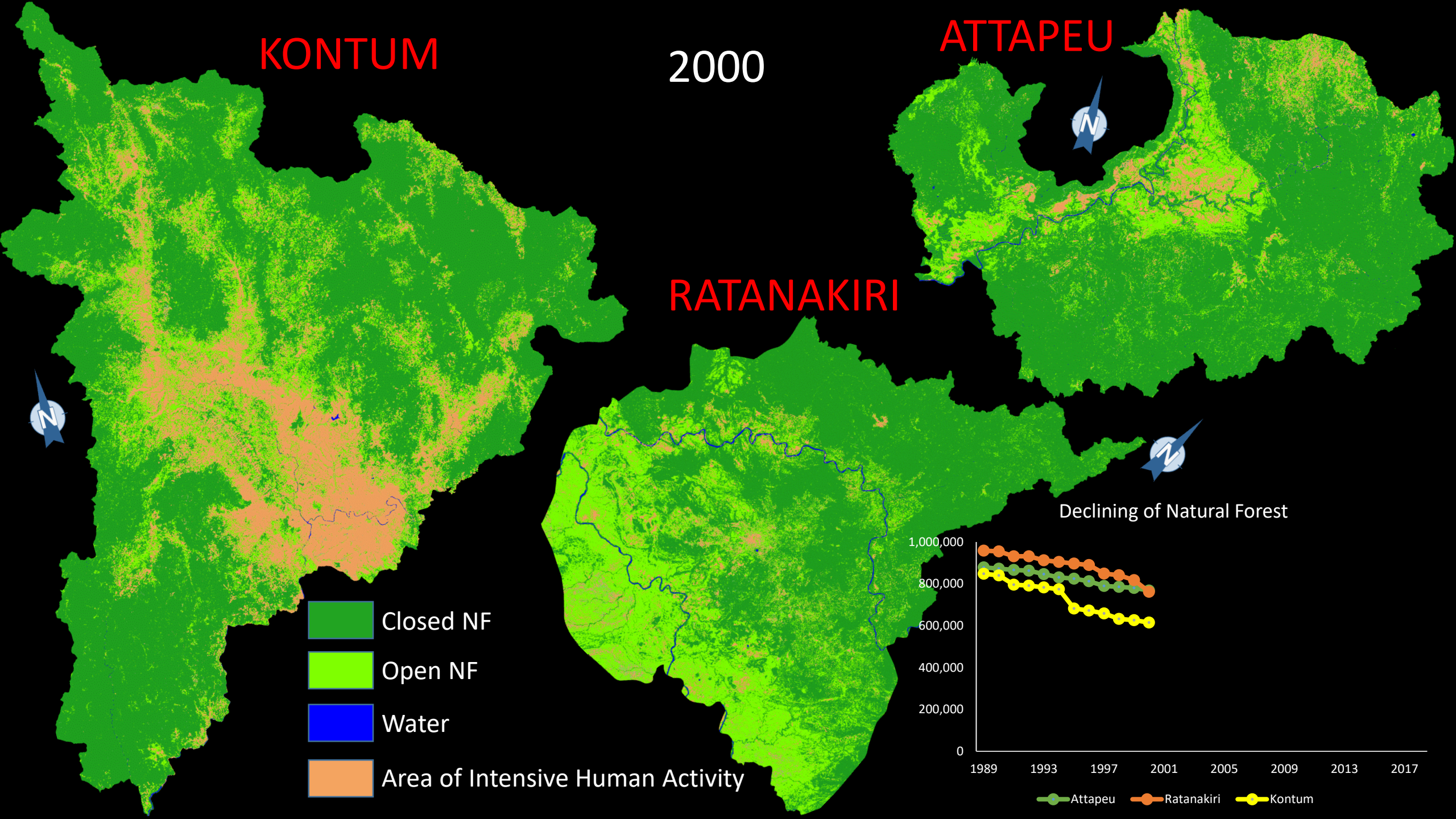
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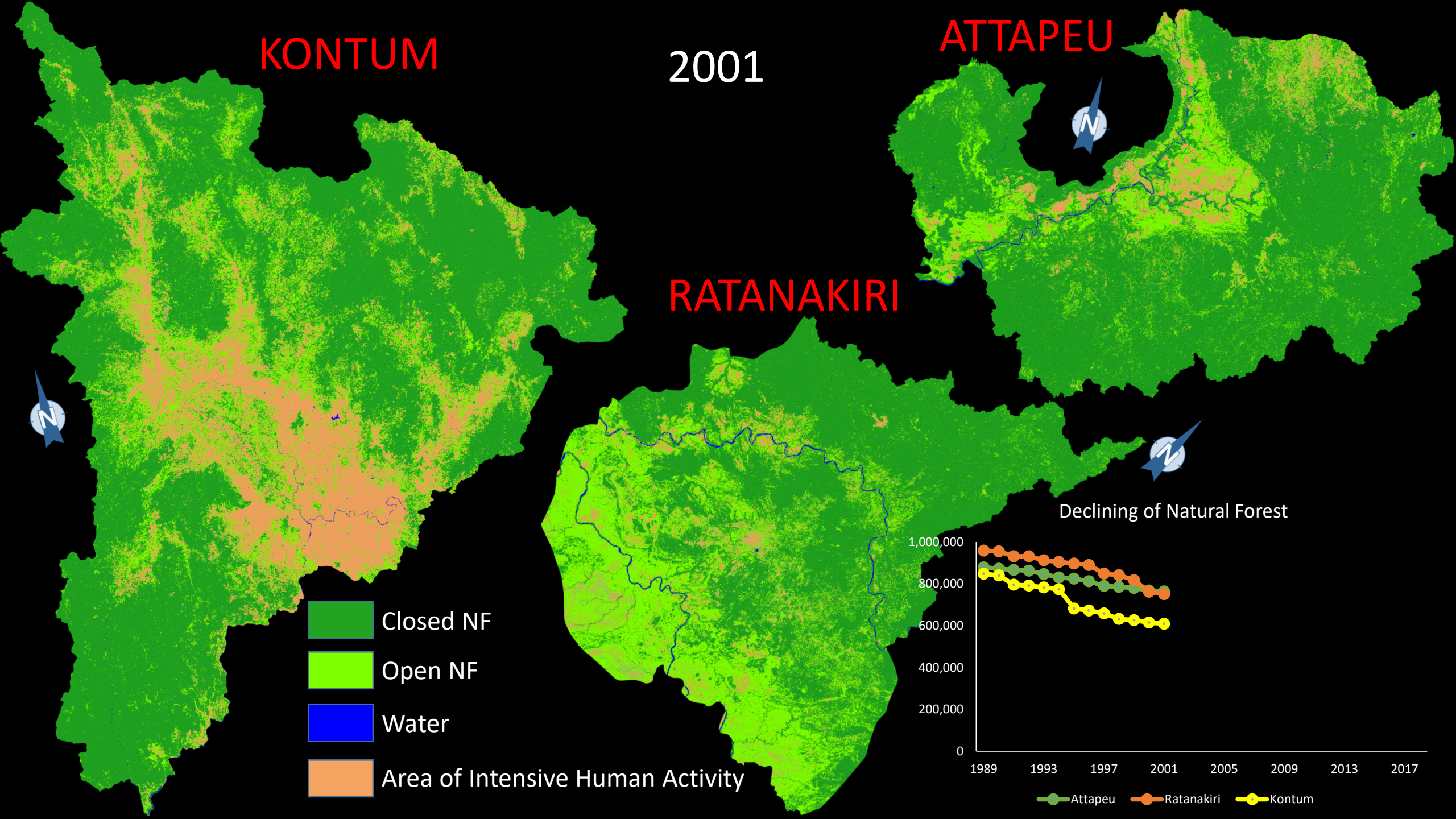
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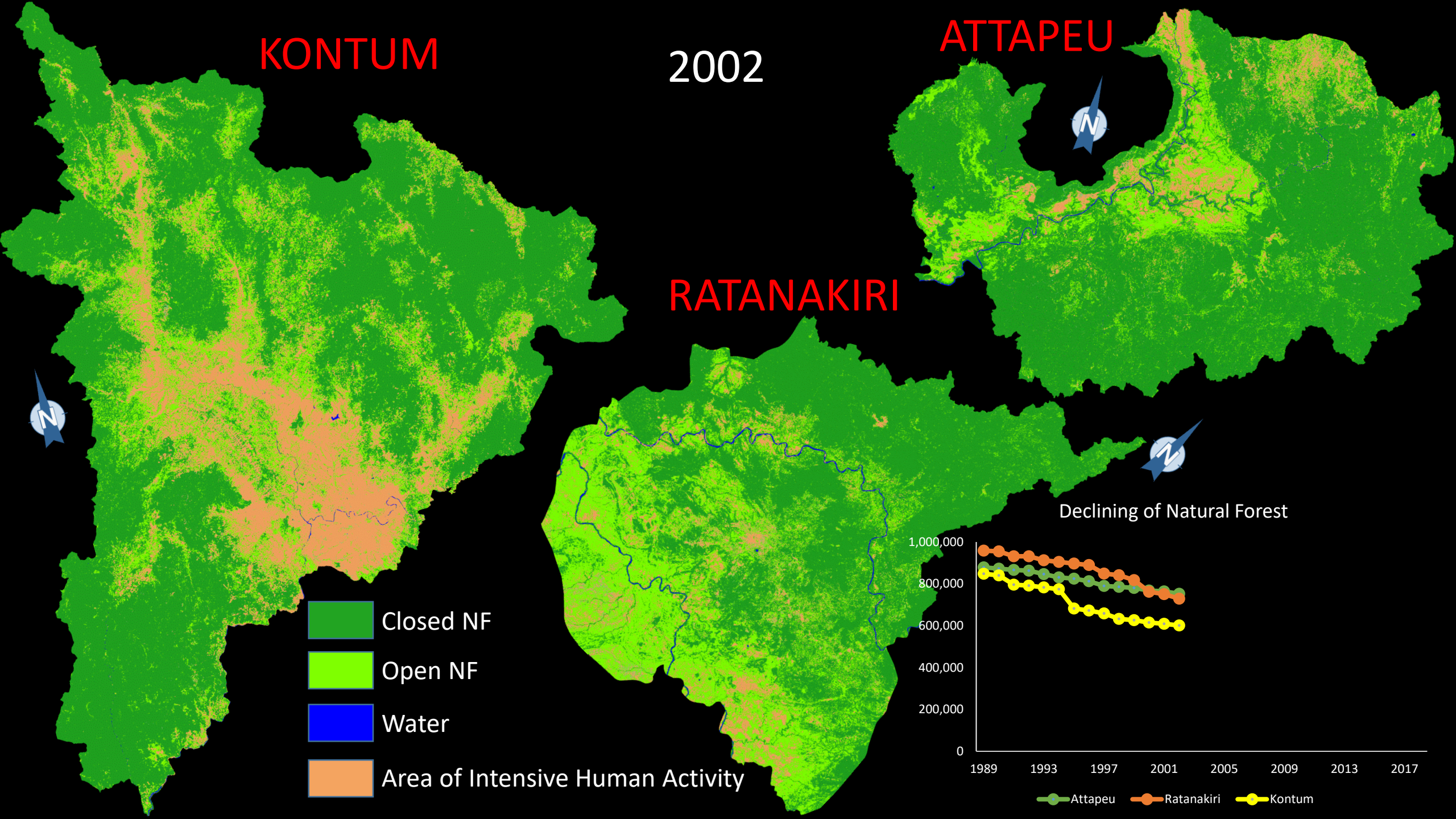
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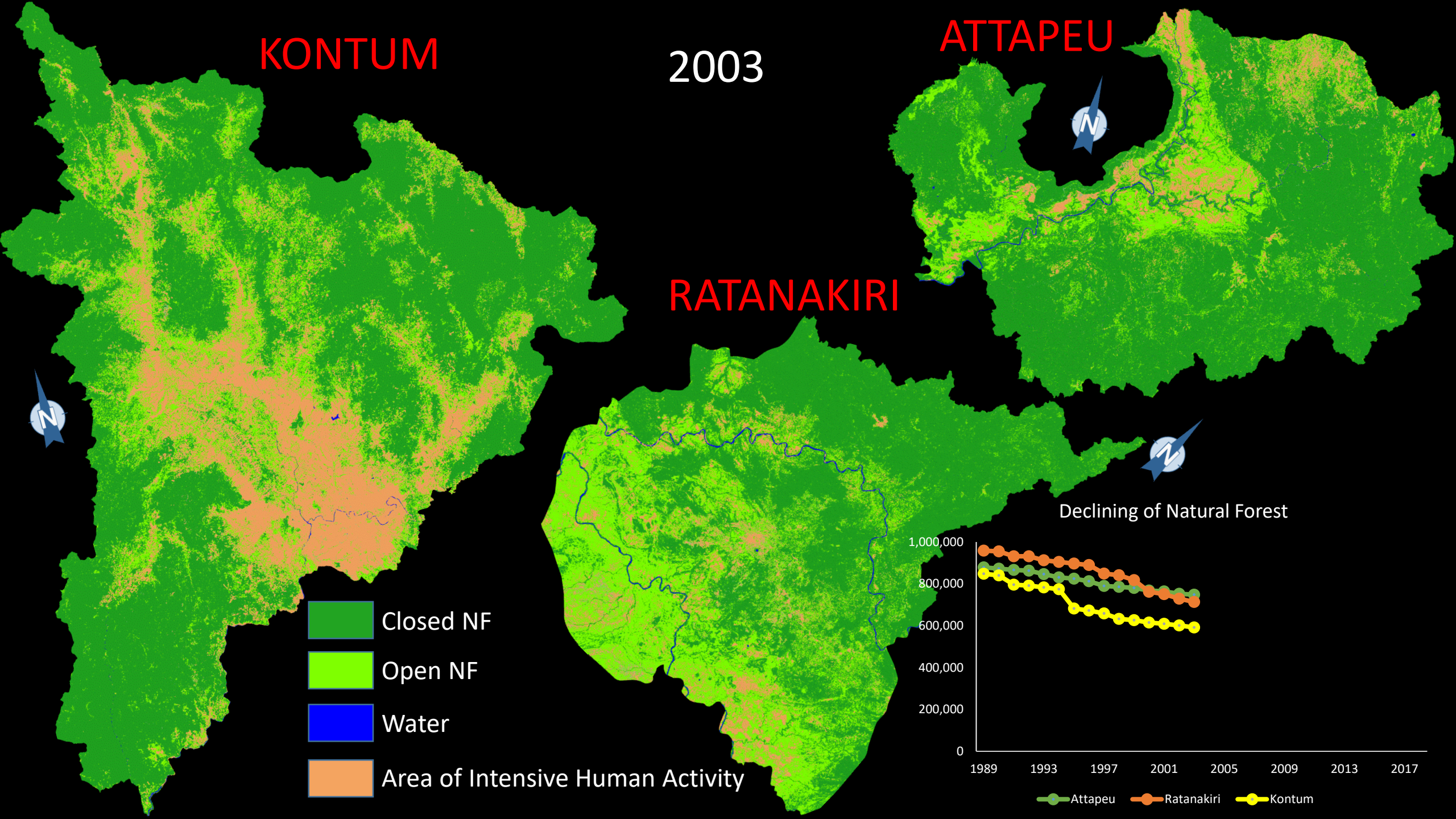
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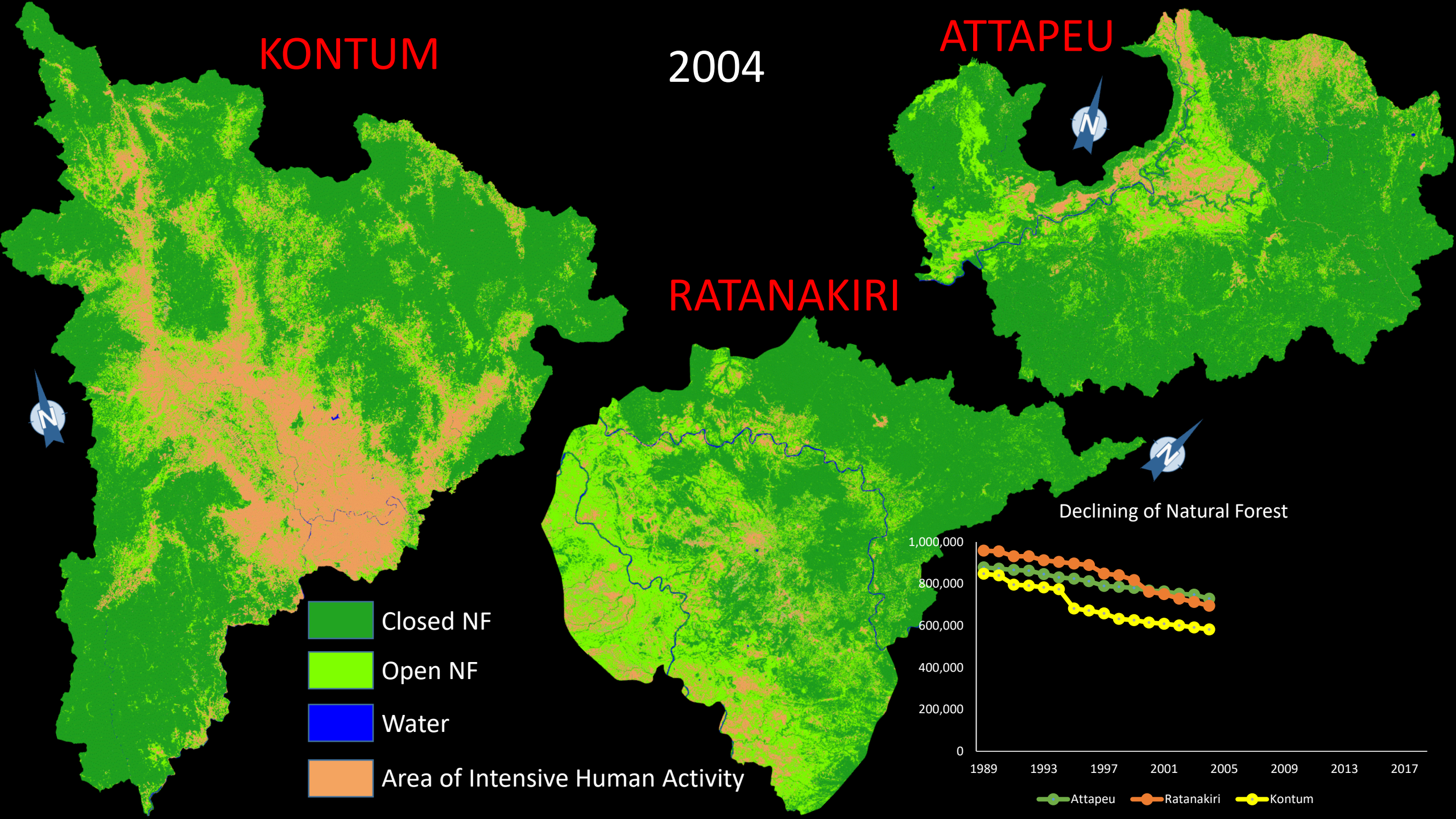
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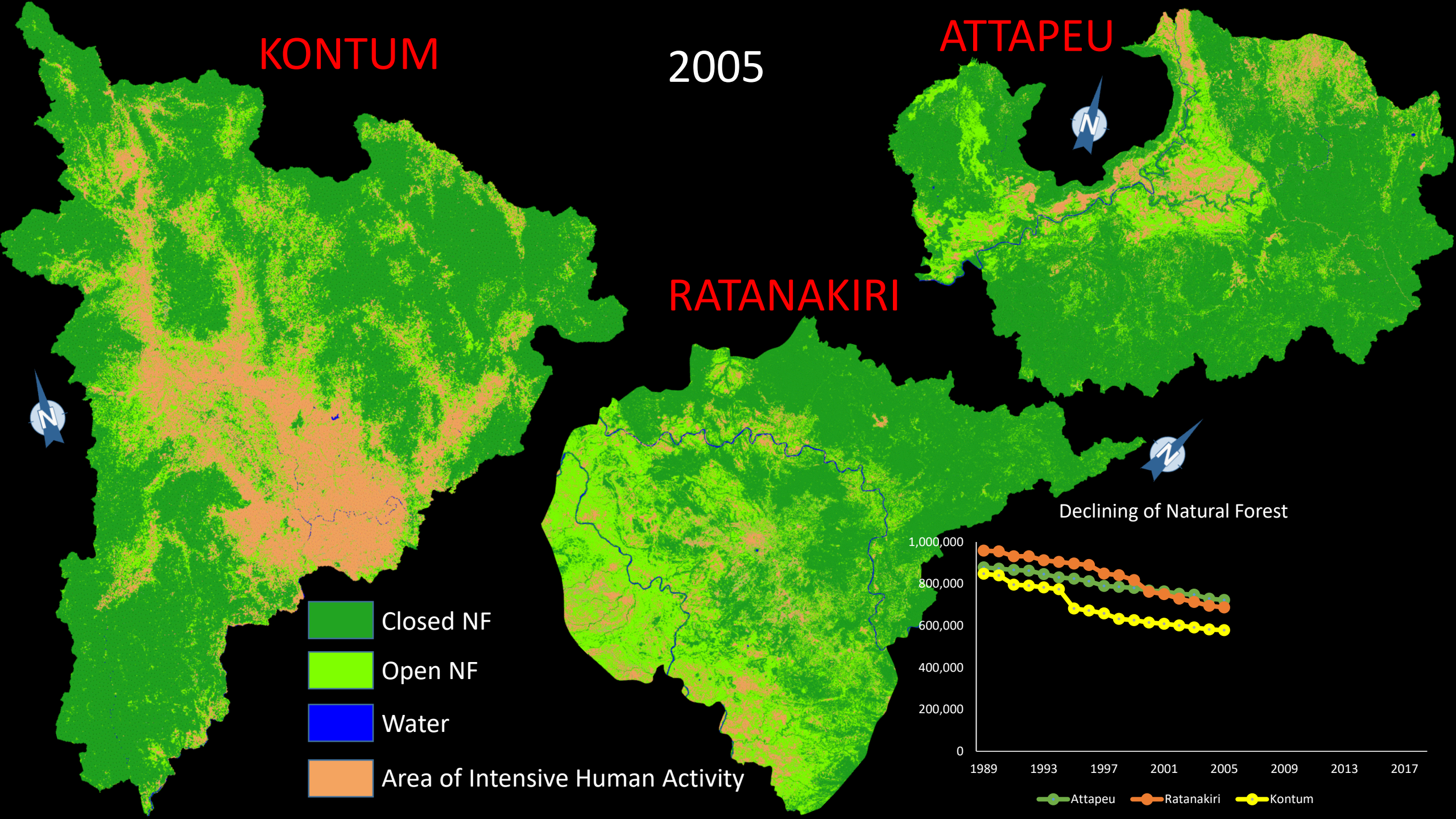
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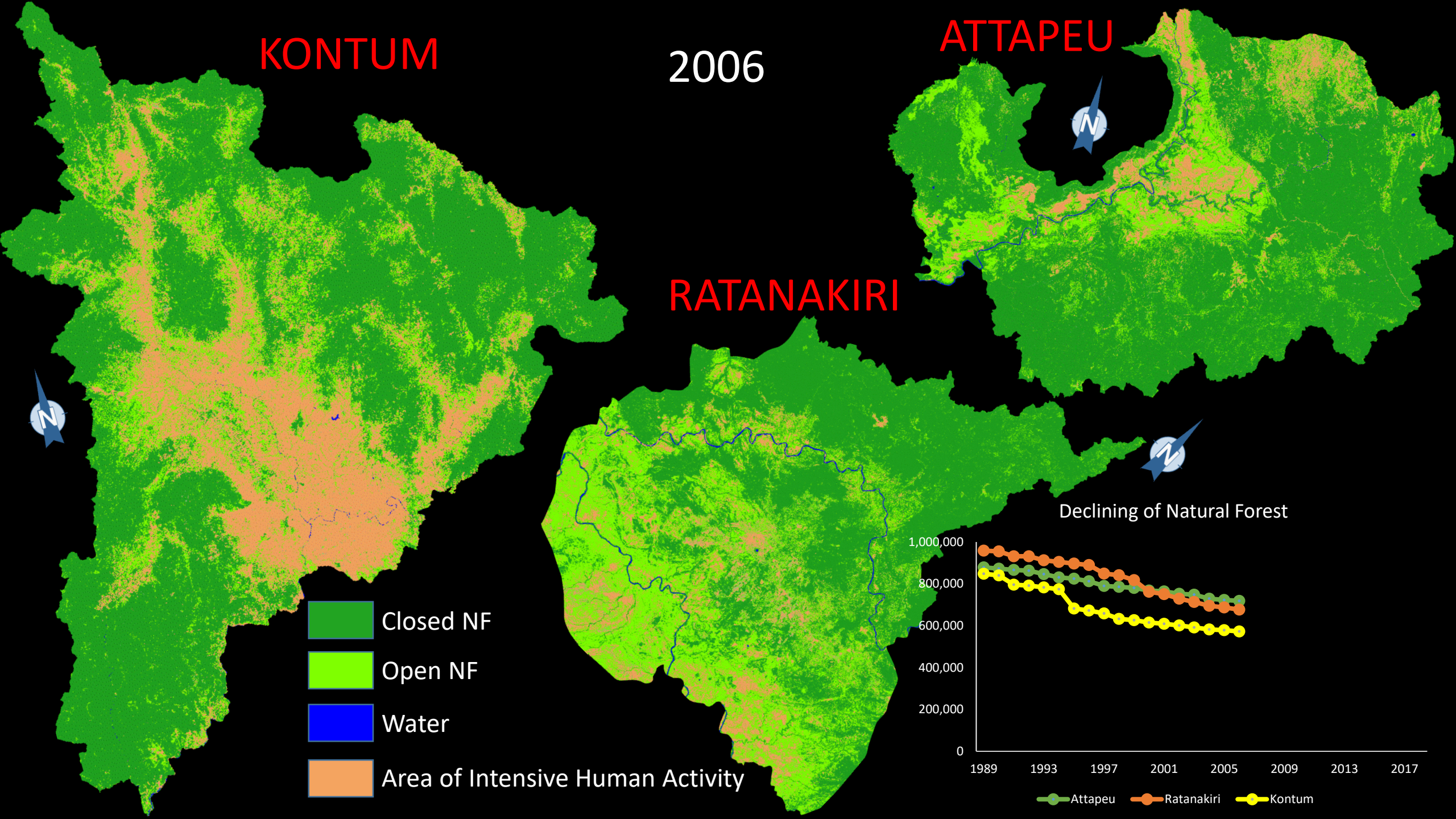
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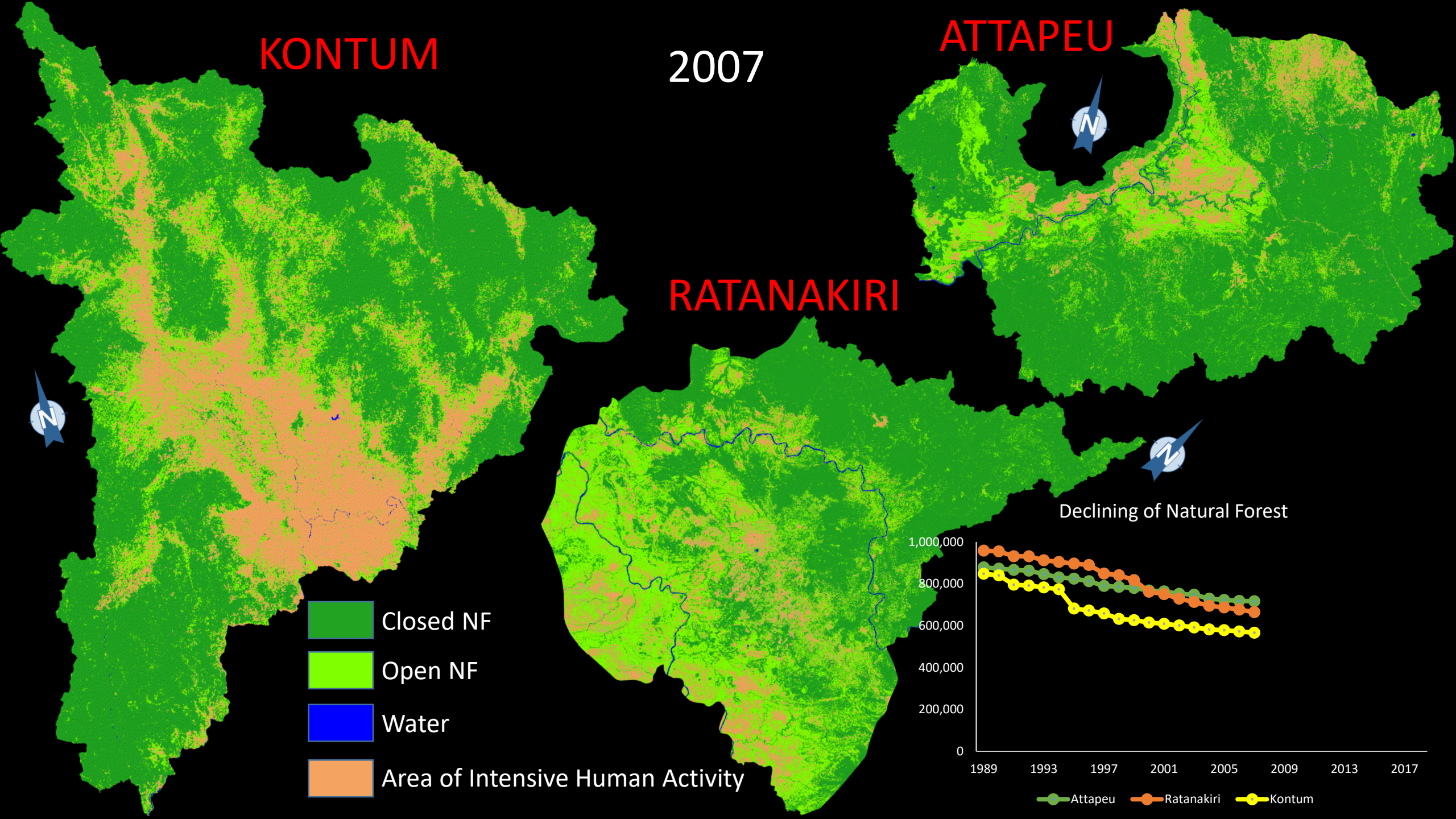
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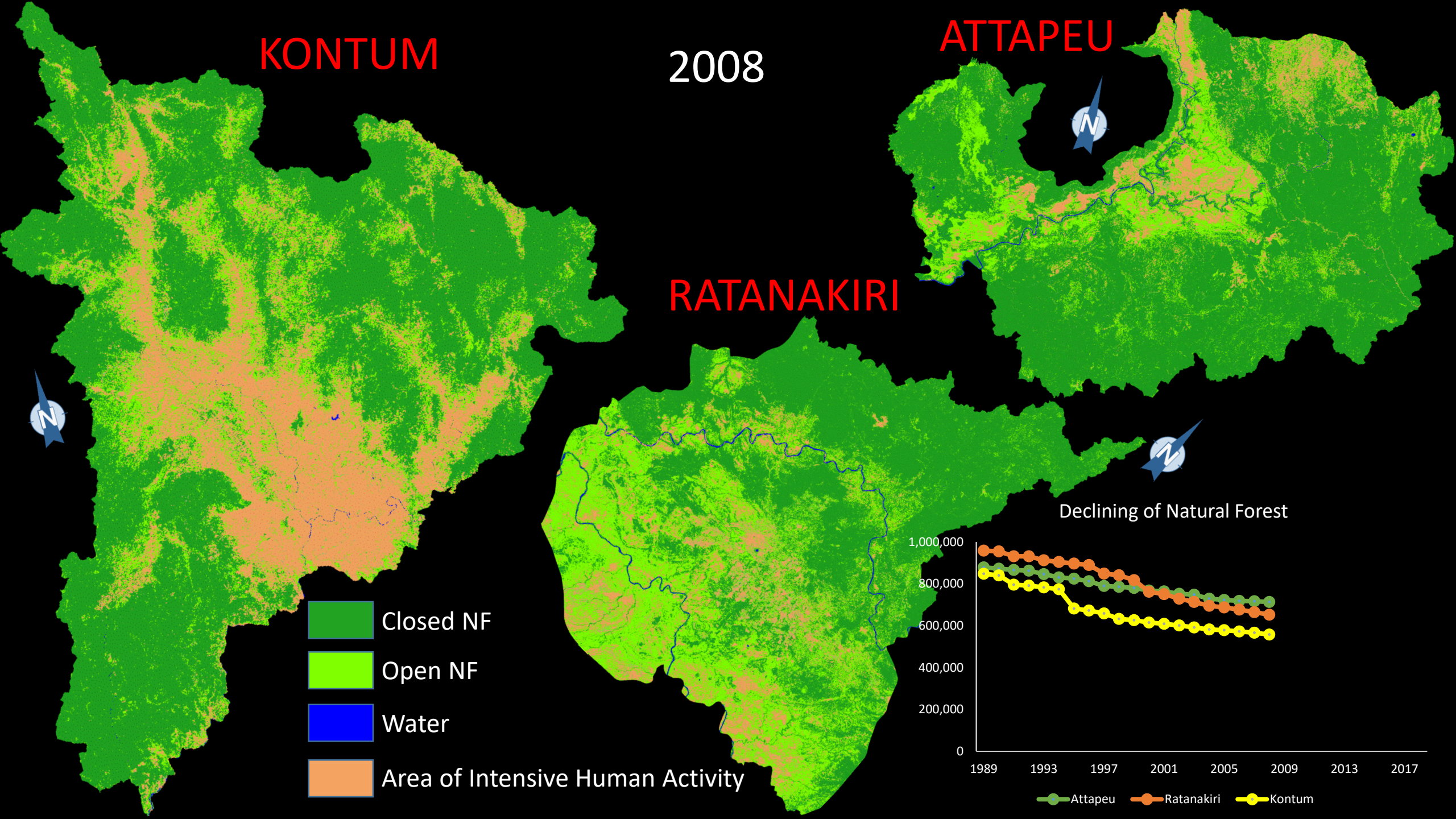
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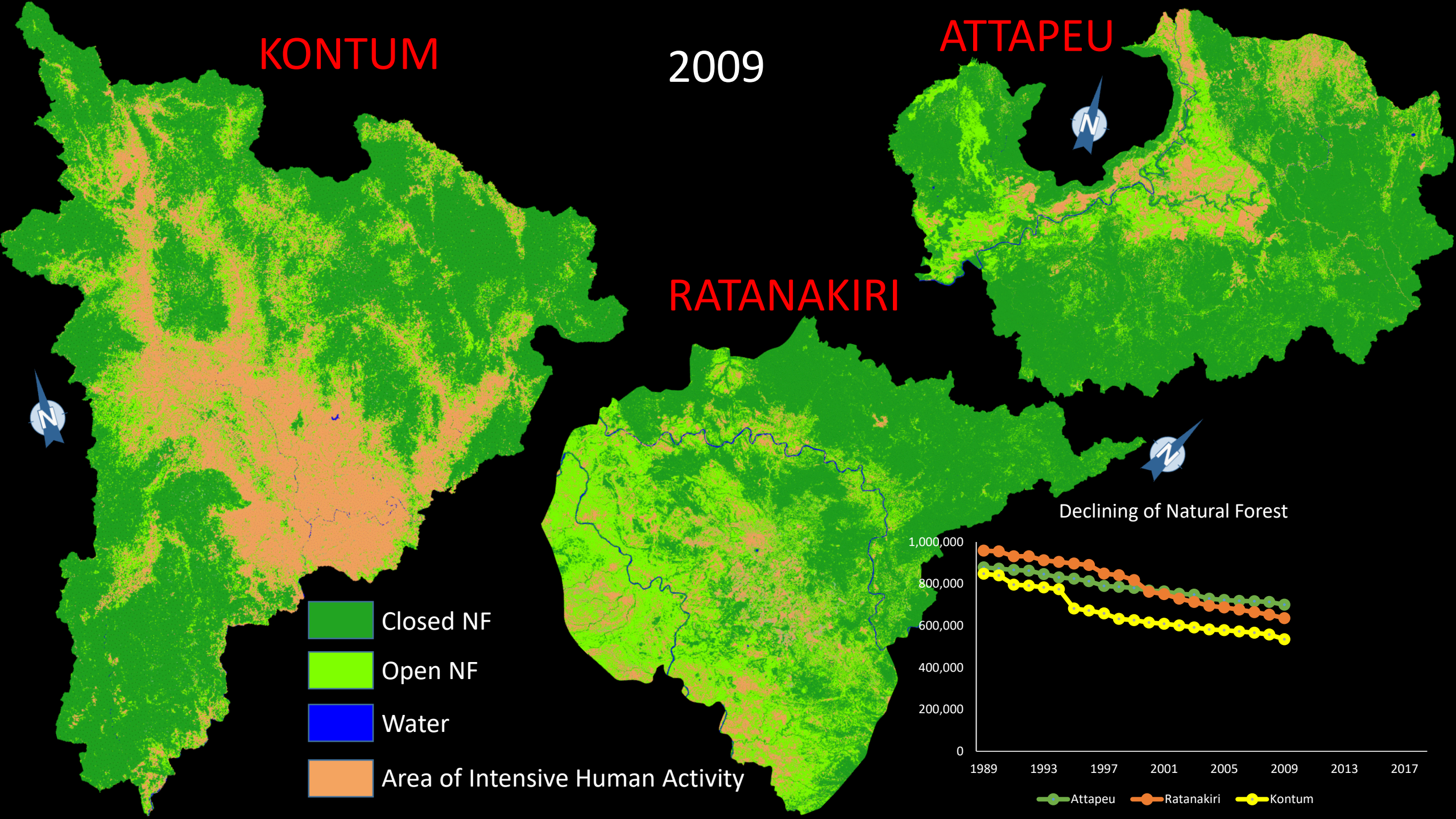
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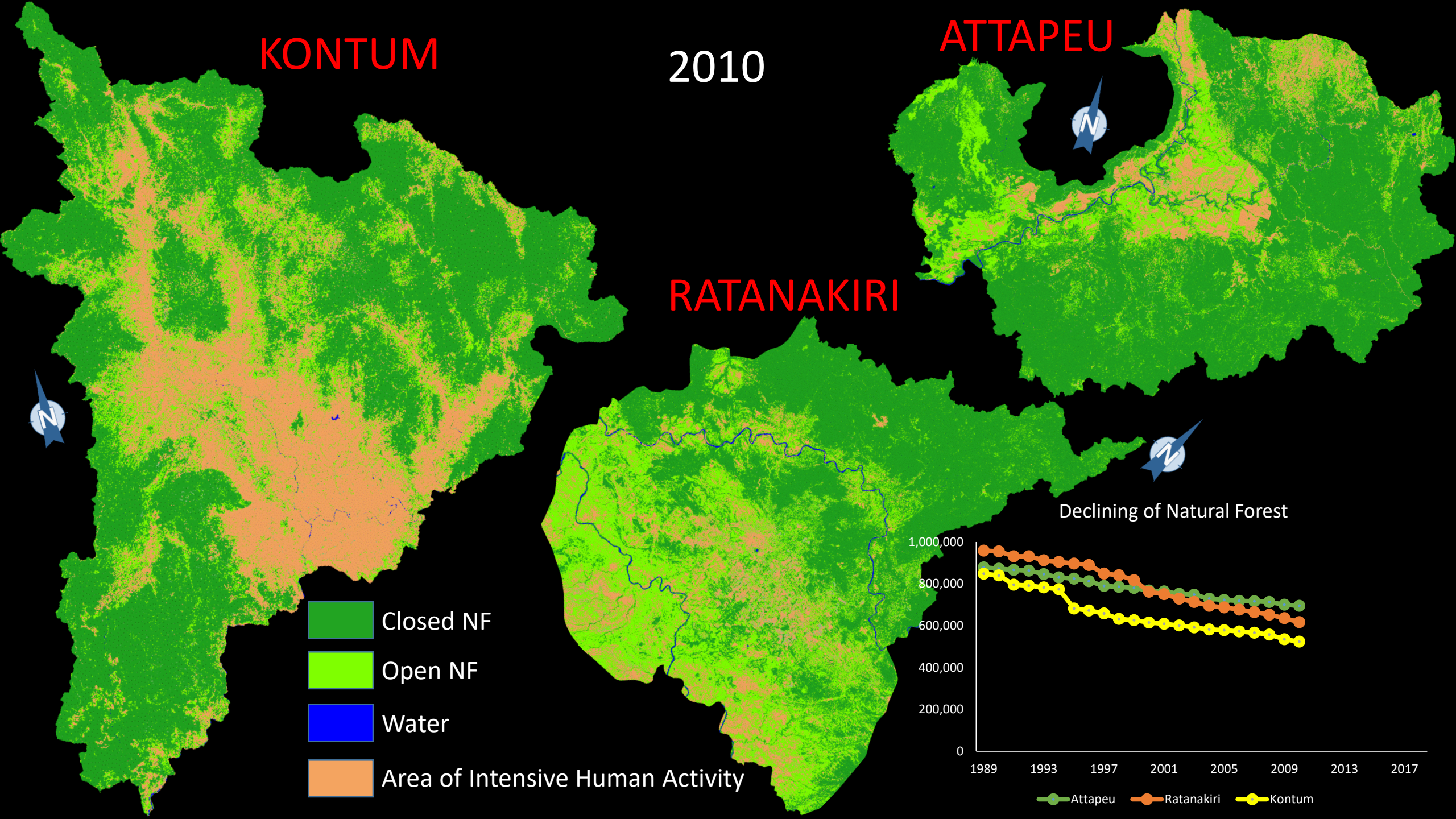
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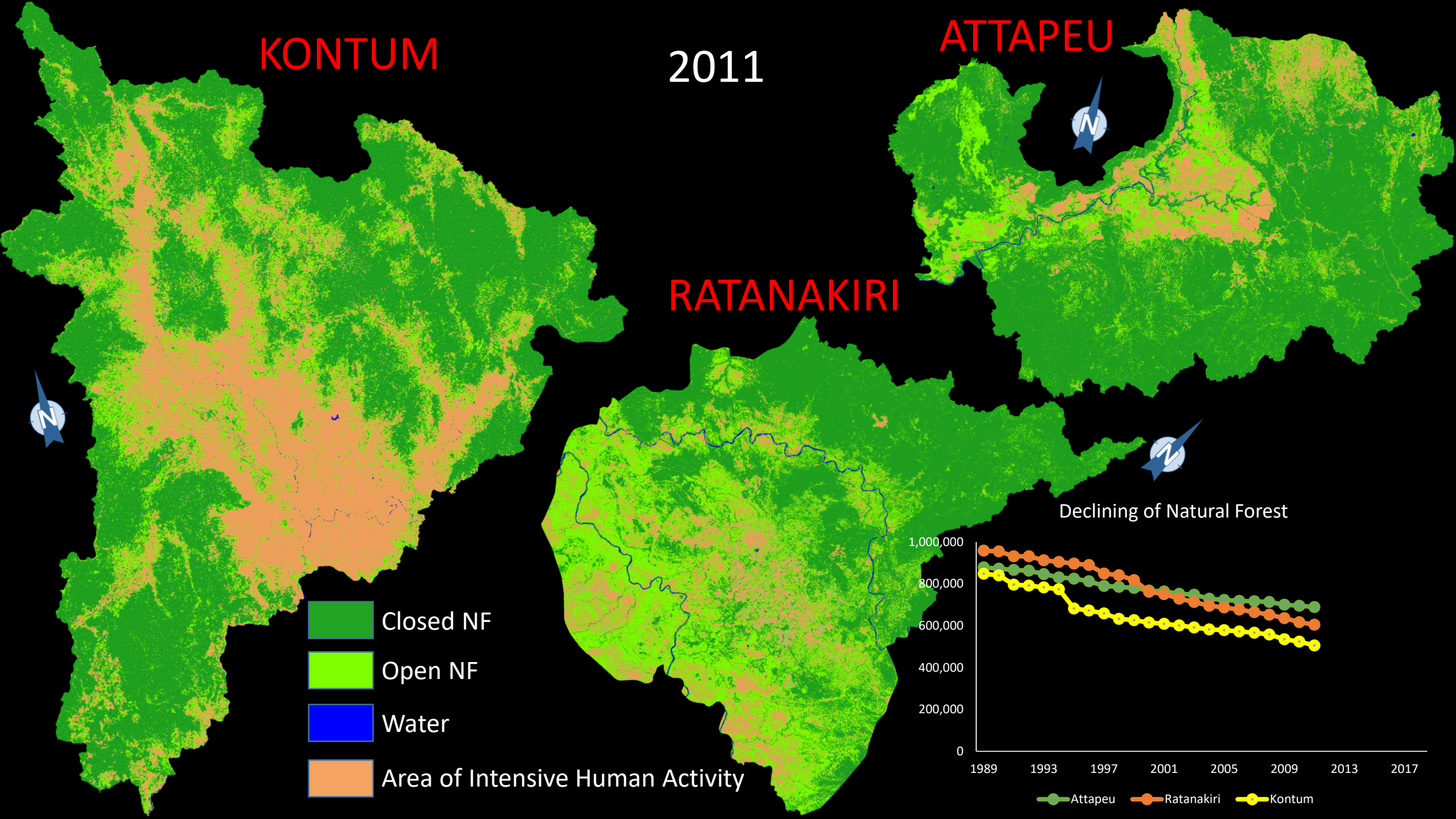
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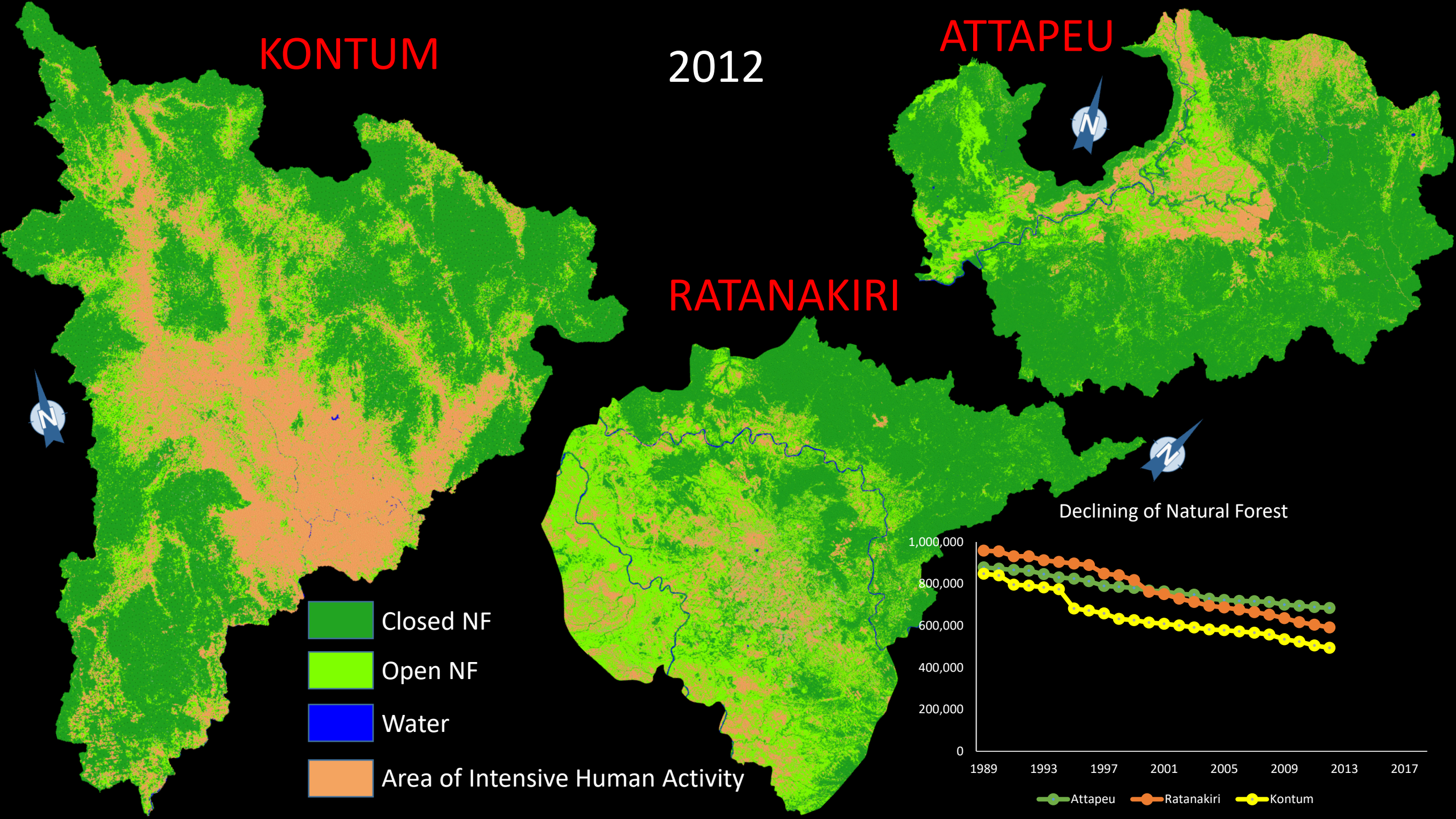
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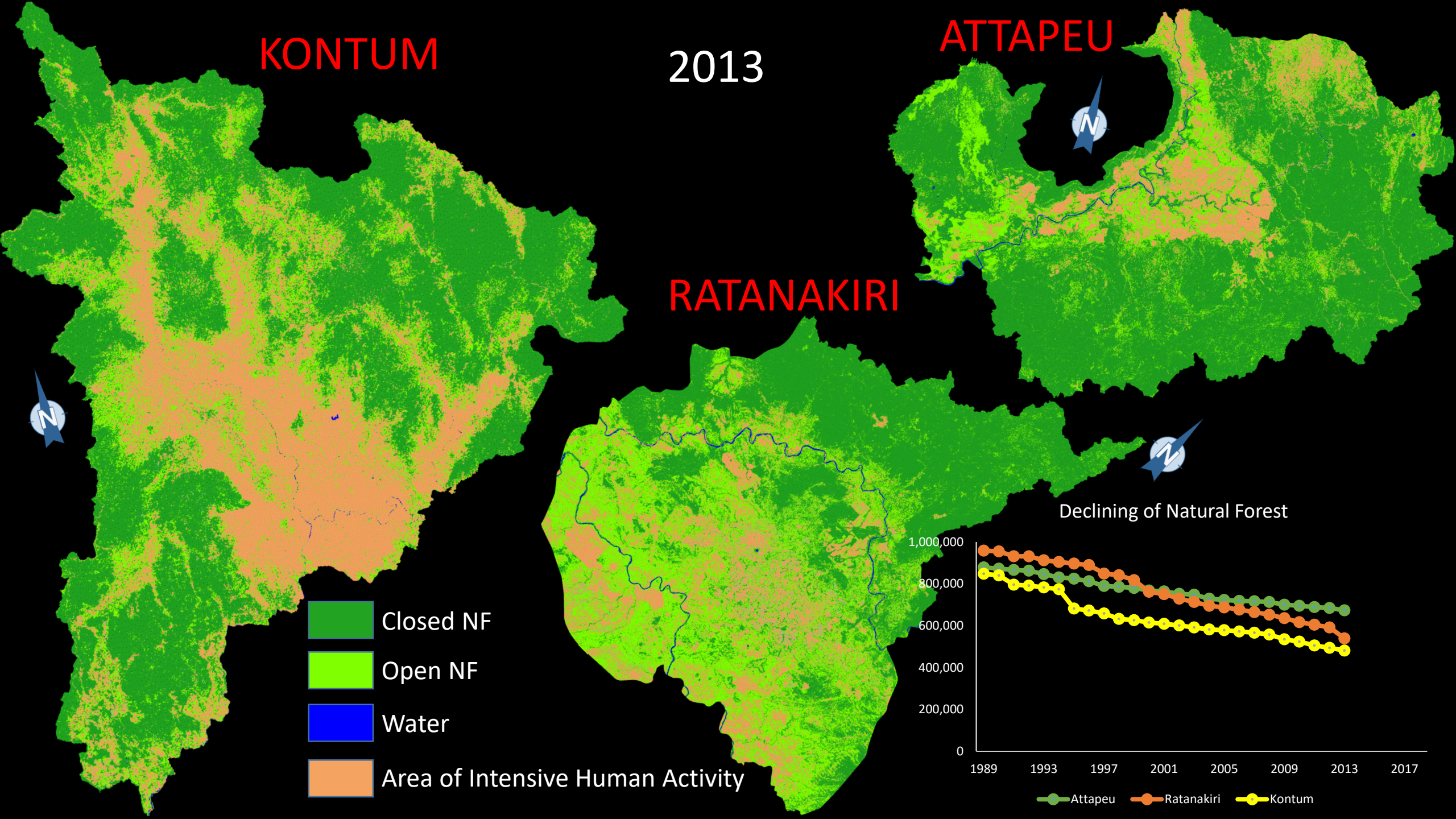
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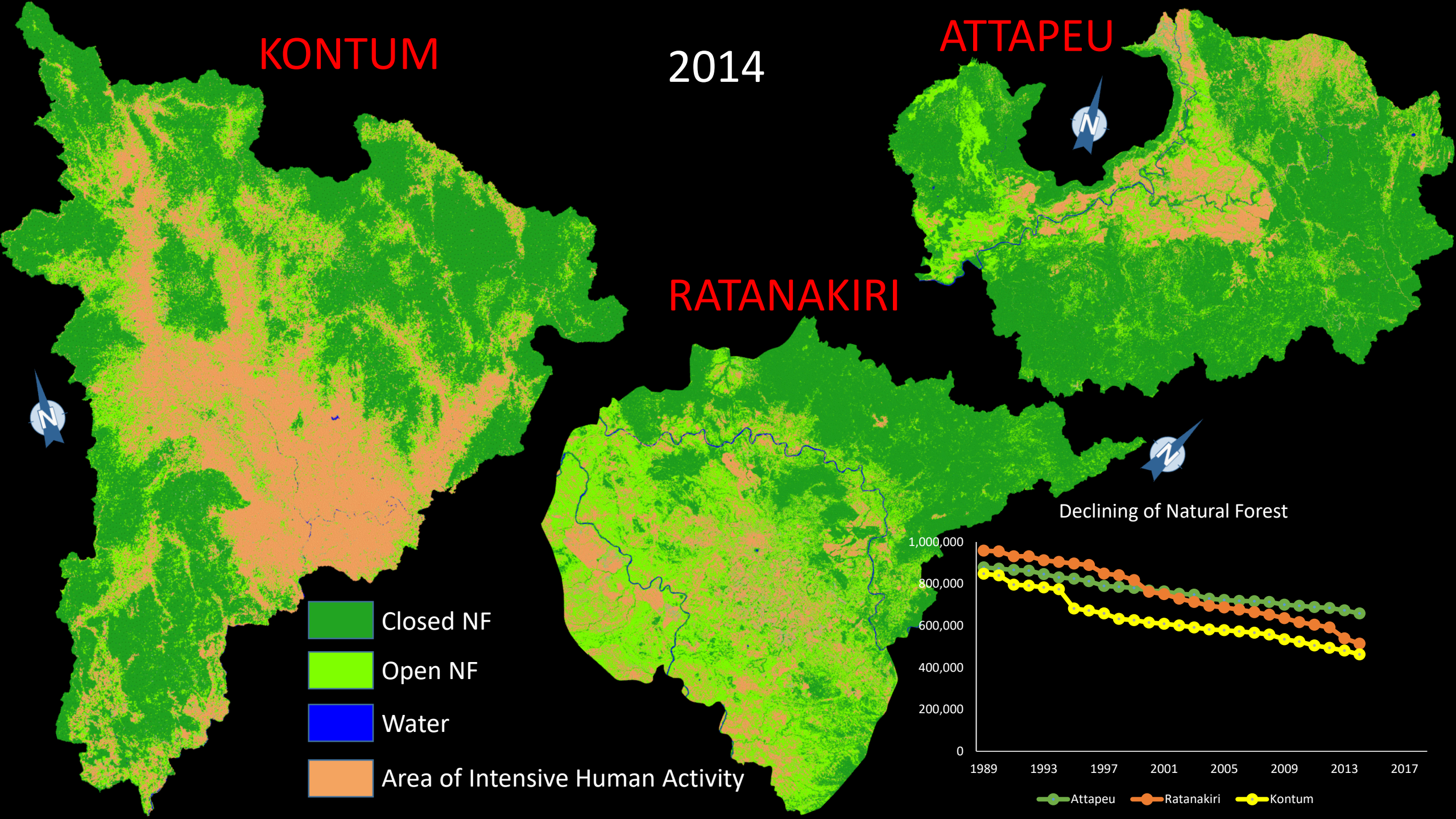
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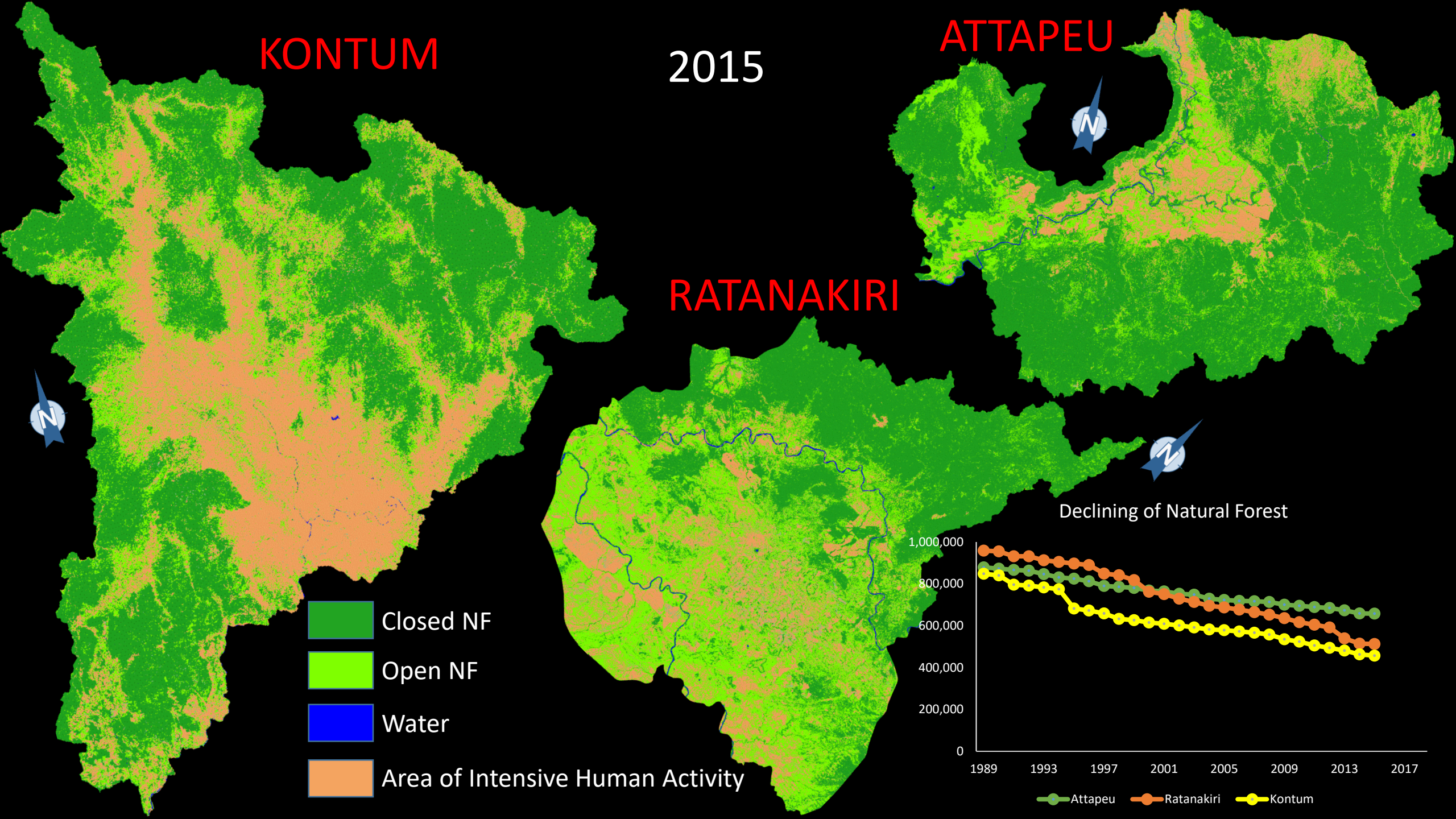
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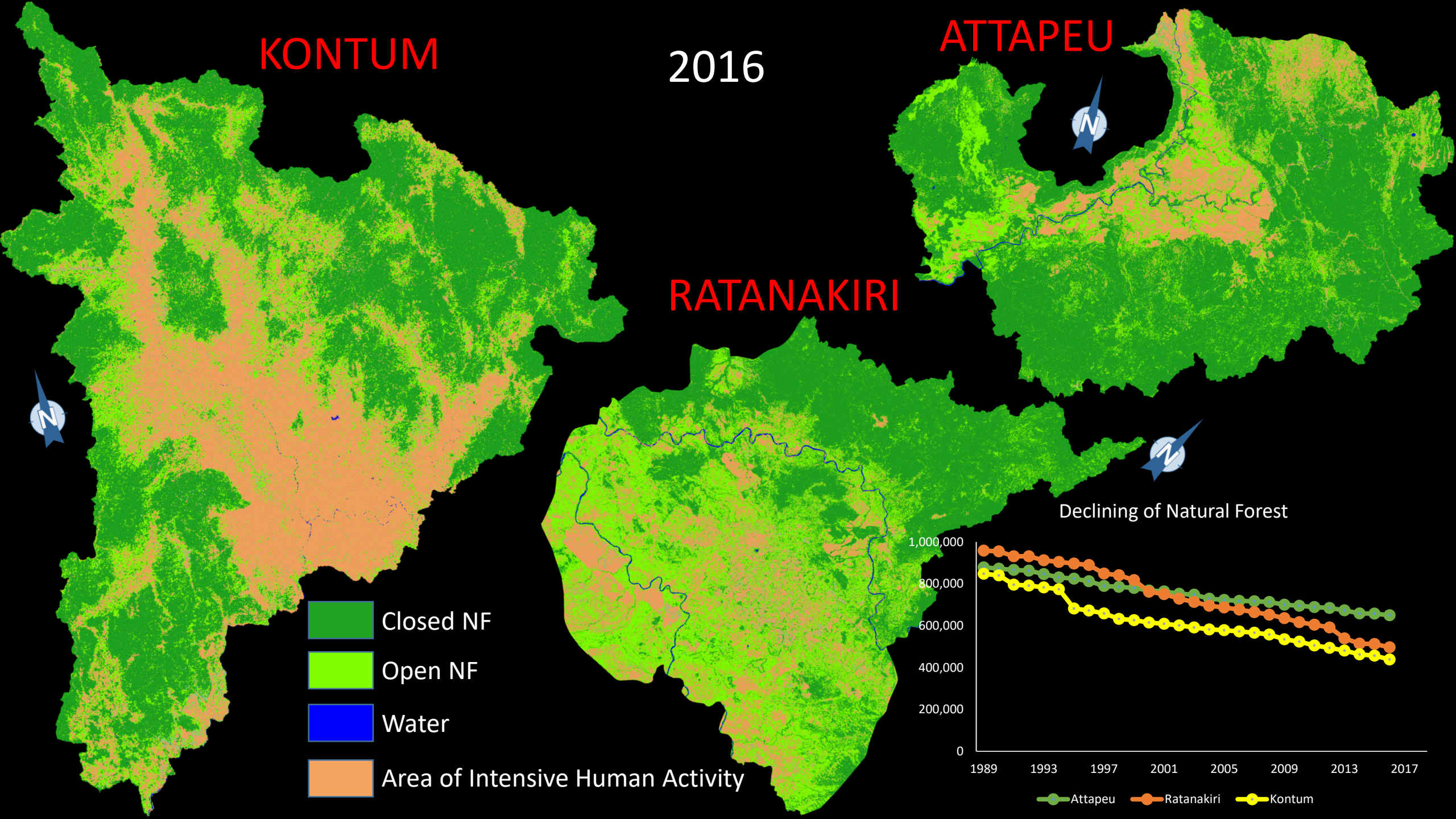
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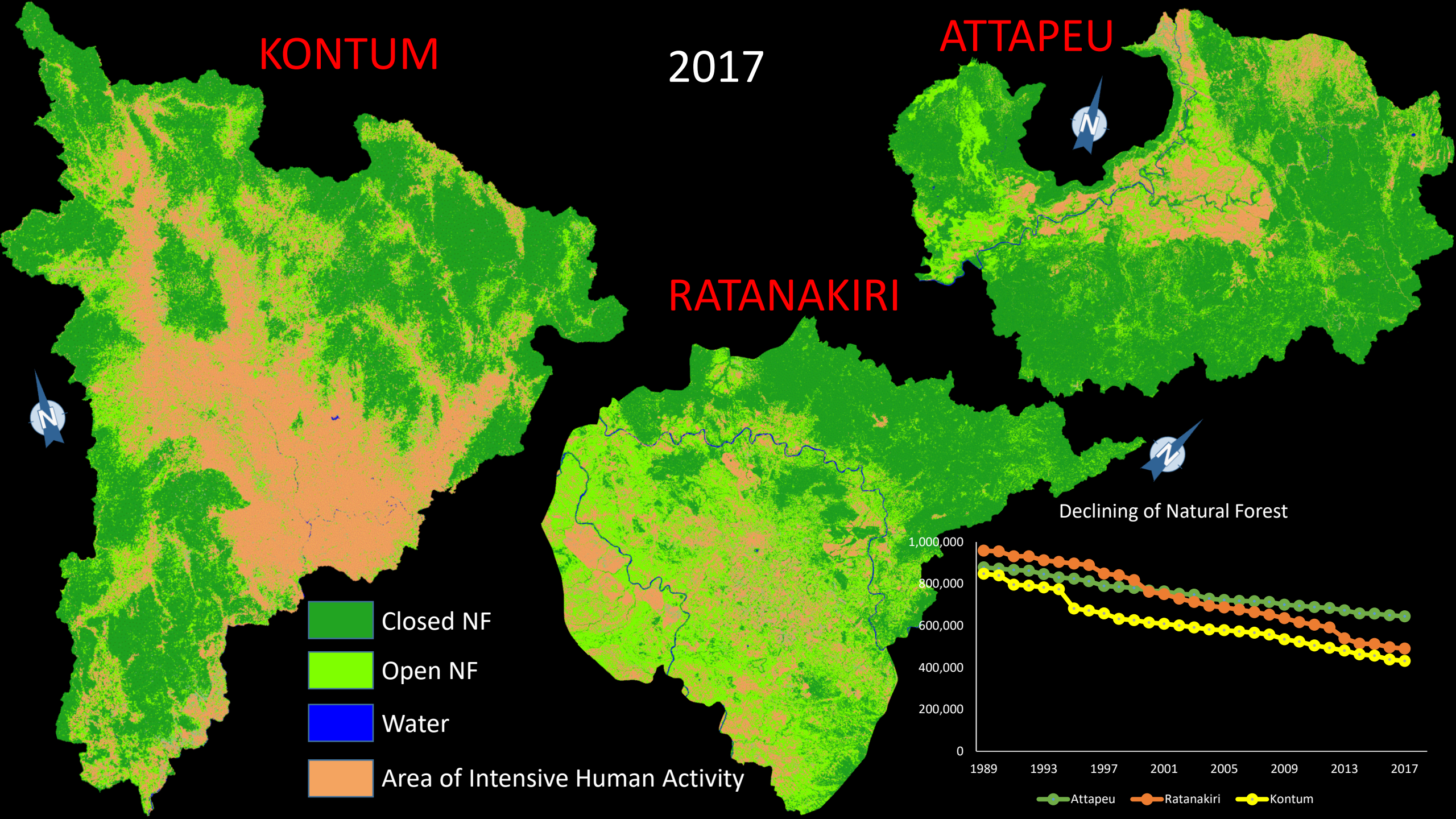
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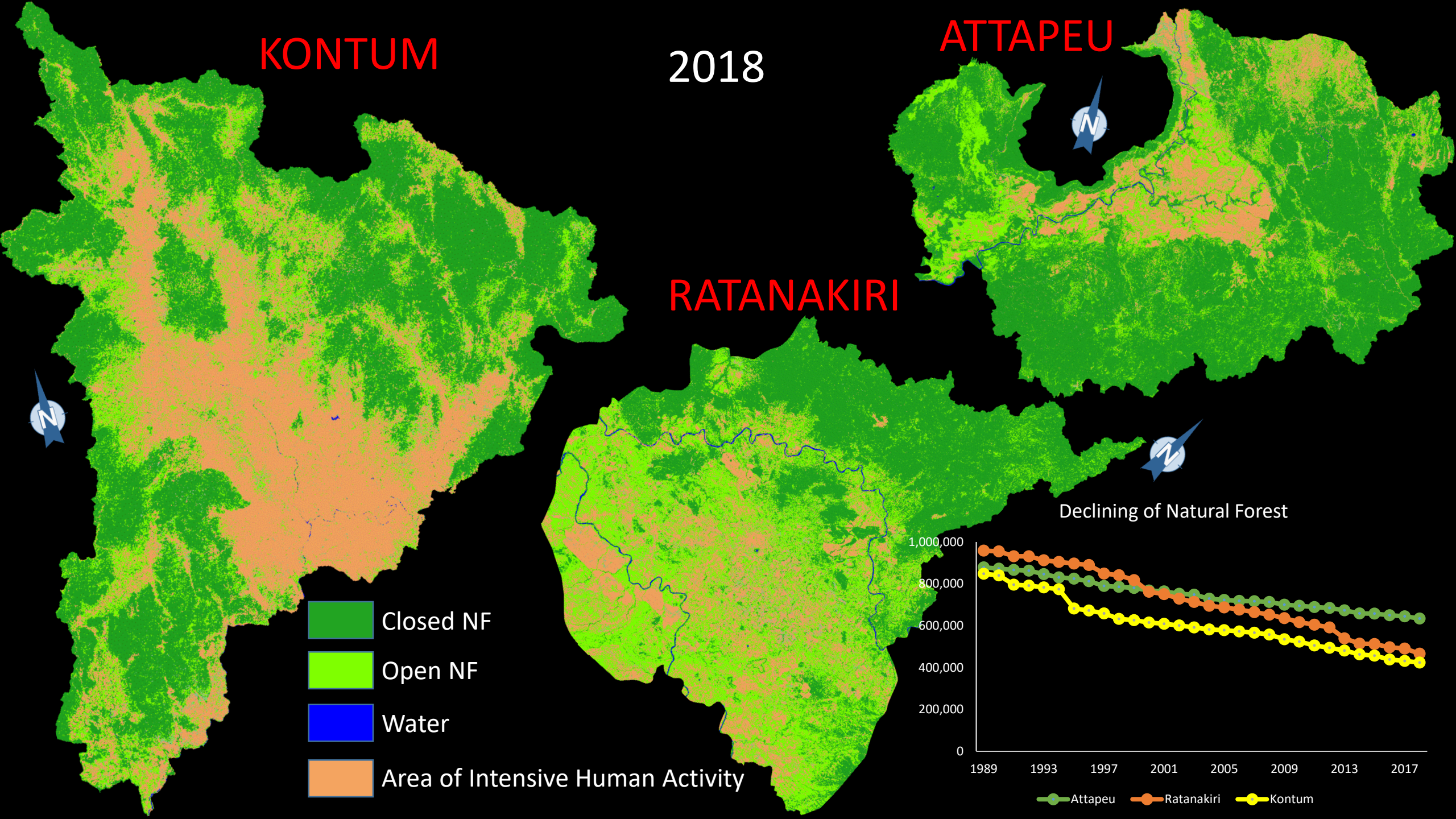
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Conclusions and Next steps

- In this presentation we demonstrated an application of spectral pattern analysis based classification of land cover to study 30-year change of natural forests in Indochina peninsula through case studies in Attapeu (Laos), Ratanakiri (Cambodia) and Kontum (Vietnam).
- The study reveals that natural forests were continuously converted , with different pace, to other lands in all three countries.
- The patterns of forested land conversion are different for different countries and the structure of the forest changes reflects distinct differences in land policies and forest land ownership in each countries.
- The proposed method has disadvantage that it requires a large amount of Landsat scenes to be analyzed.

- In future, we will expand our research to larger area and to integrate socioeconomic data to understand mechanism and driving forces of deforestation in Southeast Asia in the past 30 years.

Thank you for your attention