Life and Health in a Changing Climate

Every year, 1 Million die from Hypertensive Heart Failures, 600 Thousand die from Malaria, extreme climate events can aggravate the situation.

How will healthcare systems and the insurance industry adapt to changing climatic conditions?

Our Forecast Models

Generate disease forecasts for the next 5-10 years, helping Swiss Re understand the key factors of risk exposure over time.

Business & Social Impact

Offer insights for making effective disease-related insurance plans that fit regional climate and socio-economic conditions. Help the general public understand climate impact on disease mortality and take timely preventive initiatives.

Data

U.S. Analysis

State Monthly

Global Analysis

Country Annual

Precision Interpretability Generalizability Feature importance

1) Satellite Image Processing
Use color mapping algorithm to get the numerical values of climate features from satellite images.

2) Time-Series Feature Detrend
Eliminate the trend to help machine learning models capture the deviation of a feature w.r.t its trend.

3) Lag Analysis
1~3 months of delays are found between climate variables and disease mortality for 70% of U.S. states.

Feature Engineering

Climate Data

Temperature Water Vapor Precipitation

Census Data

Hypertensive Heart Failure

Bacterial Infectious Disease

Death/100K Pop.

Dengue & West Nile Fever

Global Burden Database

CDC

NASA

World Bank

National Climate Data Center

U.S. Census Bureau

United Nations

35 States[1]

184 Countries

6.5 M Climate Data per day

Past Climate & Census Data

Our Forecast Models

Estimate Future Disease Deaths

U.S. Analysis

Feature Importance

Generalizability

Interpretability

Precision

Project Overview

Sample Model Results[1]

Model

Bacterial Infectious

ARIMA

0.59 R²

Regression Tree

0.70 R²

Gradient Boosting

0.76 R²

RNN

0.80 R²

Model

West Nile Fever

Time Series

0.23 R²

Regression Tree

0.32 R²

Gradient Boosting

0.74 R²

Ensemble + Clustering

0.83 R²

U.S. Analysis = Recurrent Neural Network

First Stage (Time Series)

Fit global trend from 1990 - 2007 (training year) with a linear function

Use slope of global trend to predict deaths of each country from 1990 - 2016

Second Stage (Machine Learning)

Approach 1: use results of the 1st stage prediction as a feature to predict deaths

Approach 2: predict errors of 1st stage prediction and then recover deaths

Global Analysis – Ensemble Model

NY: 2016.1

Features

NY: 2016.2

Features

NY: 2016.3

Features

NY: 2016.12

Features

Global Analysis - Satellite Image Processing

Use color mapping algorithm to get the numerical values of climate features from satellite images.

Global Analysis - Time-Series Feature Detrend

Eliminate the trend to help machine learning models capture the deviation of a feature w.r.t its trend.

Global Analysis - Lag Analysis

1~3 months of delays are found between climate variables and disease mortality for 70% of U.S. states.

1) States with available disease information.

2) Model results are non-exhaustive.


Problem Statement

Every year, 1 Million die from Hypertensive Heart Failures, 600 Thousand die from Malaria, extreme climate events can aggravate the situation.

How will healthcare systems and the insurance industry adapt to changing climatic conditions?

Takeaways

Within the U.S.

Bacterial Infectious Disease

No. 1 Factor: Human Development Index

Lower HDI → Higher Mortality

High HDI + Low Precipitation (past 2-3 months) → Lower Disease Mortality

Low HDI + Low Temperature / High Water Vapor (past 2-3 months) → Higher Disease Mortality

Globally

Hypertensive Heart Failure

Risk Group Change by 2030:

1 Country:

Low → Medium Risk

12 Countries:

Medium → High Risk

4 Countries:

High → Medium Risk

All other countries stay within the same risk group.


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