Supplementary Information

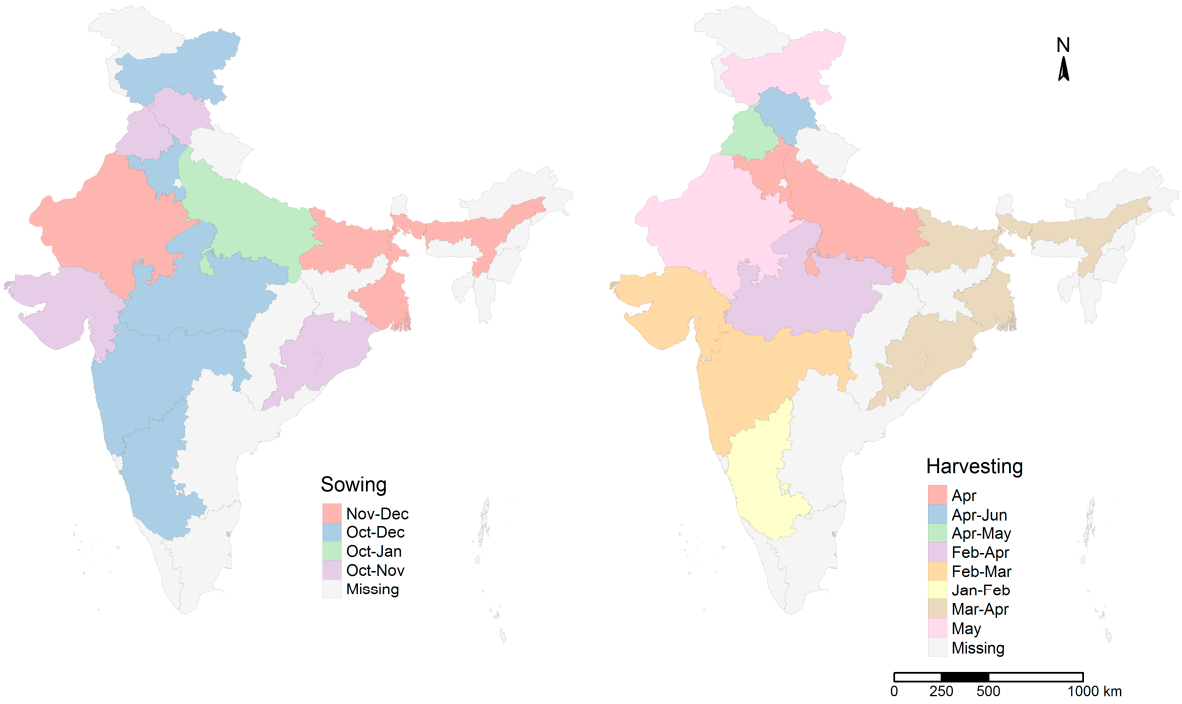

Figure S1: Map showing wheat sowing and harvesting months for major wheat growing states of India (Source: Indian Council of Agricultural Research (Crop Science Division))

Calculations

Growing Degree Day (GDD)

GDD, a weather-based indicator, helps in assessing crop development. The amount of heat required by the plant to mature is fixed; higher cumulative GDD signifies early maturity and reduced crop yield. GDD was calculated taking mean temperature over a day and subtracting a base temperature (Equation 1) using 5 °C as the base temperature (Mujherjee et al., 2019; Bauer et al., 1984). The base temperature is decided when the plant growth is below zero. Cumulative GDD was computed using daily minimum and maximum temperature for 30 years (1975-2005 and 2021-2050) from sowing to harvesting date.

$$GDD=Tmax+Tmin2-Tbase \quad \text{(Equation 1)}$$

Where, T_{max} is minimum temperature, T_{min} minimum temperature and T_{base} is 5°C.

Coefficient of Variation (CoV) of monthly precipitation

The monthly average temperature was extracted at district level, and the CoV was computed for October-May for each district for climate change scenarios as wheat cultivation starts from October and continues until May.

Standard Precipitation Index (SPI)

SPI, a drought index, was computed using monthly precipitation data for 30 years using *SPI SL 6* software. SPI values ranging from 0 to -0.99 were categorized as mild drought, -1.00 to -1.49 as moderate drought, -1.50 to -1.99 as severe drought, -2.00 or less as extreme drought and values > 0 indicated no drought. Further, frequency of no, mild, moderate, severe and extreme drought was estimated.

Weighing method explanation

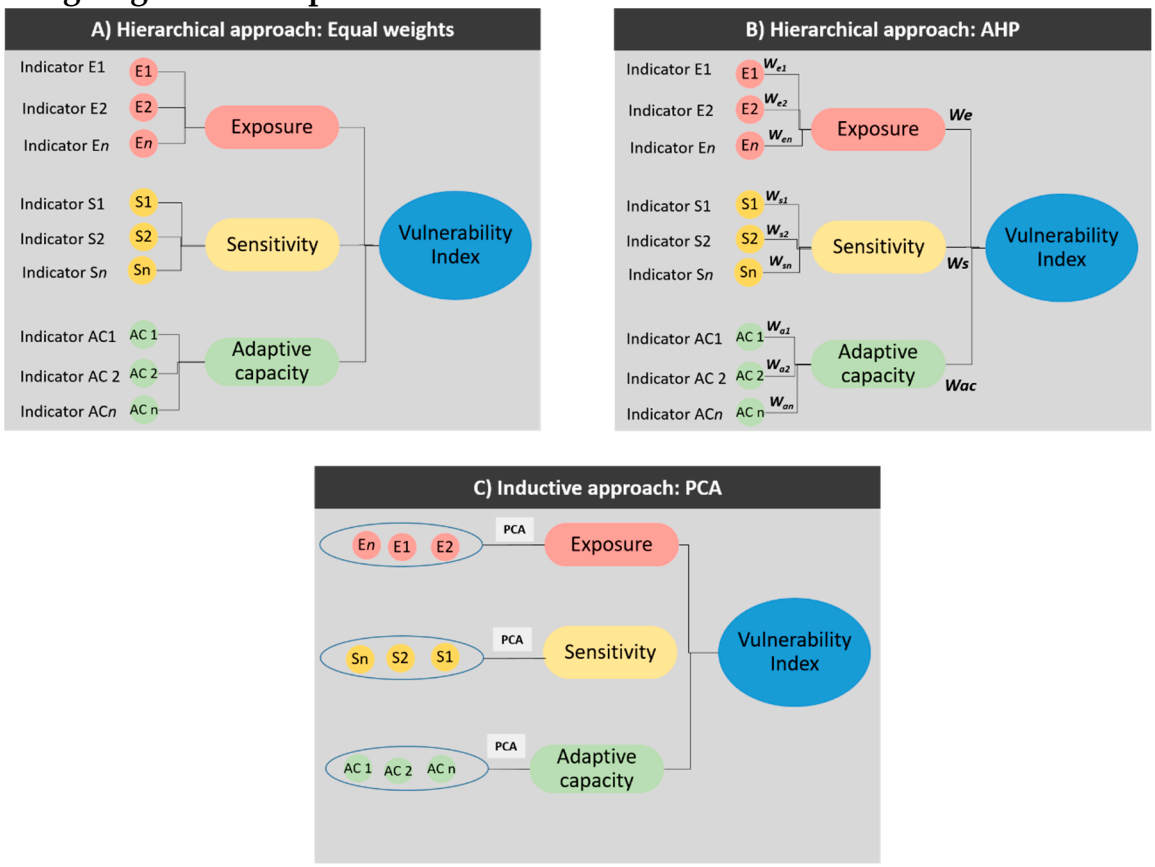

Figure S2: Schematic representation of three weighing methods for constructing vulnerability index. A) and B) represent Hierarchical approach, whereas C) represent an inductive approach to assign weights. A set of 27 indicators were selected and then treated differently across the three (A, B,C) approach.

<u>In approach A) Equal weights:</u>

$CI = \sum_{i=1}^{il} \quad W_i X_{ij}$ (Equation 1)

Where, Wi = 1 for all the indicators

<u>In approach B) AHP:</u>

$CI = \sum_{i=1}^{il} \quad W_i X_{ij}$ (Equation 2)

Where, Wi = for each indicator varies from 0 to1. Sum of weights for indicators under each vulnerability component i.e. $W_{e1} + W_{e2} + \ldots + W_{en} = 1$

In approach C) PCA:

$$CI = \sum_{i=1}^{iI} W_i X_{ij} \qquad \text{(Equation 3)}$$

Giving Weights using PCA – PCA is a statistical method which is used to reduce the dimensionality of the dataset to form new variables such that new variables explain the maximum amount of variability in the data.

The factors with Eigen value greater than 1 are selected for analysis and weights are formulated using the Eigen values:

$W_i = E_i / (E_1+E_2+ ..+E_n)$

Here, W_i is weight of factor i, E_i is Eigen value of factor i, E1is Eigen value of factor 1, E_2 is Eigen value of factor 2, and n is the factor with Eigen value > 1