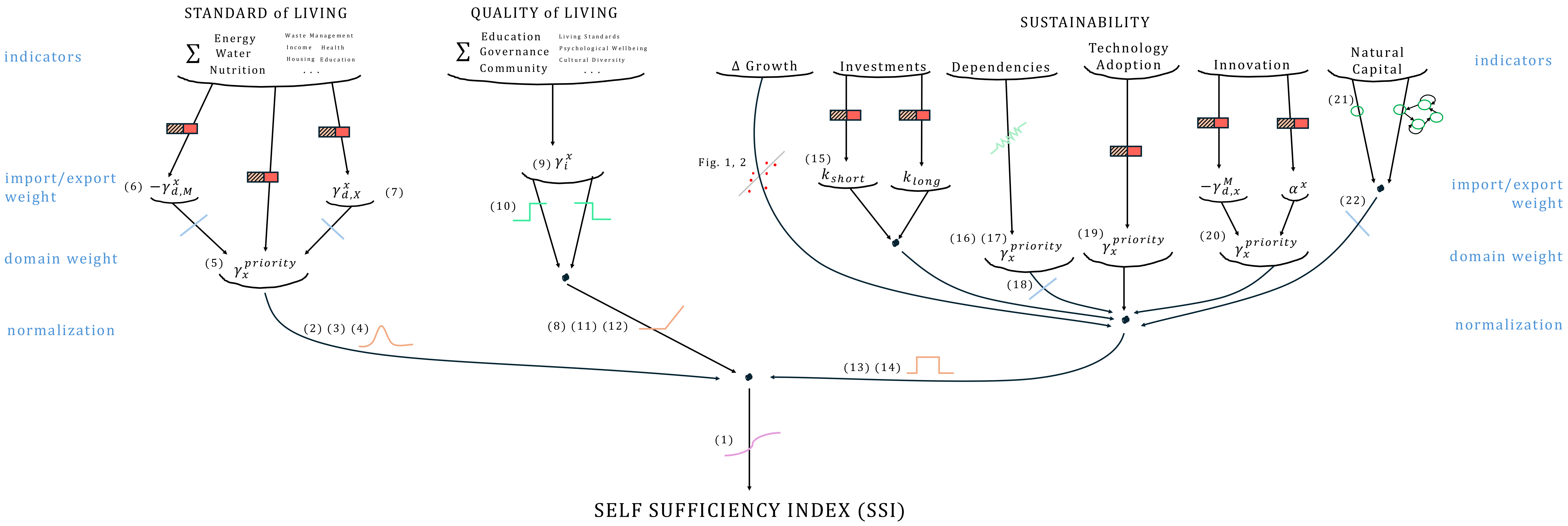

There are no widely adopted metrics in rural development for concepts like self-sufficiency. This body of work aims to develop a Self Sufficiency Index (SSI) that can be applied broadly across Indian villages with different geographical, cultural, and sociopolitical contexts as a robust, comparative marker for rural development via a bottom-up approach, from which technology and policy strategies can be drawn and further evaluated. Ultimately, this body of work views the village as a node in a powerful, distributed system for development. Thus far, the village's potential for innovation has largely remained latent. SSI seeks to rigorously assess and stimulate local, contextualized problem-solving.

SSI is a composite index of standard of living (SL), quality of life (QL), and Sustainability (S). SL and QL are standard dimensions. Here, SL corresponds to commodities, while QL refers to the "functionings" and "capabilities". In this work, objective indicators are used for SL and a combination of objective and subjective indicators are used for QL. The sustainability dimension (S) takes into account the past and present to project into the future of the village, asking whether a village that today, maintains SL and QL for its residents, is able to do so reliably over time.

Index General Form

$$SSI = \sqrt[3]{SL \times QL \times \text{Sustainability}} \tag{1}$$

where SL = standard of living, normalized $\in [0, 1]$
QL = quality of life, normalized $\in [0, 1]$
Sustainability(S), normalized $\in [0, 1]$

Standard of Living (SL)

notation:

a domain within a set of domains: $x \in D$
indicators within domain x are denoted $i \in x$
X = exports; M = imports; d = distance from village

$$SL = \frac{SL_{initial}}{3} + \frac{1}{3} \tag{2}$$

$$z = \frac{SL_{initial} - \mu}{\sigma};\ SL = z \longrightarrow percentile \tag{3}$$

$$SL = \frac{n}{N} \tag{4}$$

where n = number of villages below $SL_{initial}$ and N = total villages assessed.

$$SL_{initial} = \sum_{x \in D} \gamma^x_{priority} \left[\frac{x_{\text{local production}}}{x_{demand}} - \gamma^x_{d,M} \frac{x_{\text{remaining demand}}}{x_{\text{demand}}} + \gamma^x_{d,X} \frac{x_{\text{excess production}}}{x_{\text{demand}}} \right] \tag{5}$$

where $\gamma^x_{priority}$ = domain priority weight and $\sum_{x \in I} \gamma^x_{priority} = 1$

$\gamma^x_{d,M}$ represents imports-distance weight $\in (0, 1]$
sample distance-biased weighting scheme:

$$\gamma^x_{d,M} = \begin{cases} 0.2 & \text{if } 0 < d \le 10\,\text{km} \\ 0.5 & \text{if } 10 < d \le 50\,\text{km} \\ 0.7 & \text{if } 50 < d \le 100\,\text{km} \\ 1 & \text{if } d > 100\,\text{km} \end{cases} \tag{6}$$

$\gamma^x_{d,X}$ represents exports-distance weight $\in (0, 1]$
sample distance-biased weighting scheme:

$$\gamma^x_{d,X} = \begin{cases} 1 & \text{if } 0 < d \le 10\,\text{km} \\ 0.7 & \text{if } 10 < d \le 50\,\text{km} \\ 0.5 & \text{if } 50 < d \le 100\,\text{km} \\ 0.2 & \text{if } d > 100\,\text{km} \end{cases} \tag{7}$$

$\gamma^x_{priority}$ reflect local priorities across production sectors. (6) and (7) encourage local imports and exports, should there be shortages or excess in production, respectively.

Quality of Life (QL)

$$GNH = H^H + (H^U \times A^U_{suff}) \tag{8}$$

where H^H = incidence of happy people
H^U = Incidence of not-yet-happy people, $(H^H)'$
A^U_{suff} = Average sufficiency score among H^U

$$x_{fulfilled} = \begin{cases} 1 & \text{if } \sum_{i \in x} \gamma^x_i\, i_{score} \ge 0.66 \\ 0 & \text{else} \end{cases} \tag{9}$$

$$h_{fulfilled} = \text{individual happy state boolean} = \begin{cases} 1 & \text{if } \sum_{x \in D} x_{fulfilled} = \sum_{x \in D} x \\ 0 & \text{else} \end{cases} \tag{10}$$

$$A^U = \sum_{x \in D} \gamma^x_{priority}\, x_{fulfilled} \tag{11}$$

$$H^H = \frac{\sum h_{fulfilled}}{N};\ H^U = 1 - H^H \tag{12}$$

where N = total population

Sustainability (S)

$$S = \frac{R + I_G + D + T + C + K_N}{6};\ [0, 1] \tag{13}$$

or

$$S = \sqrt[6]{R\, I_G\, D\, T\, C\, K_N};\ [0, 1] \tag{14}$$

R, Δ Growth

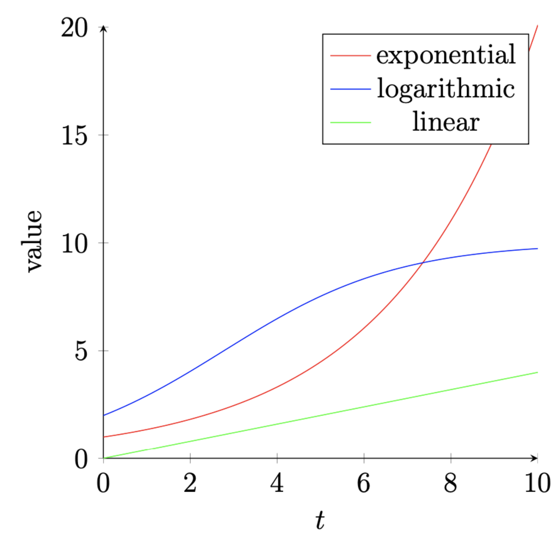

Figure 1: Growth Curves

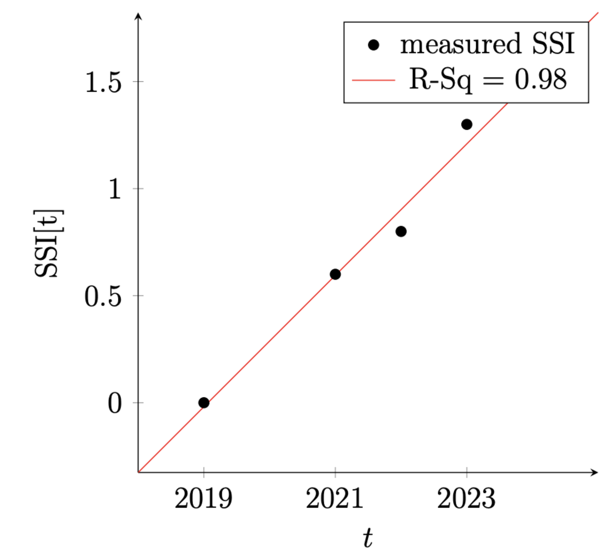

Figure 2: R-squared goodness of fit

I_G, Short and Long Term Investments

$$I_G = k_{short} \frac{I_G^{short}}{I_G^{total}} + k_{long} \frac{I_G^{long}}{I_G^{total}} \tag{15}$$

where $k_{short} + k_{long} = 1$

D, Cooperation and Dependencies

$$\epsilon = \sum_{x \in I} \left[\gamma^x_{priority} \frac{\delta SoL^x_X}{SoL_X} \Big/ \sum_{v \in villages} \frac{\delta SoL^v_x}{SoL^v_x} \right] \tag{16}$$

$$\epsilon = \sum_{x \in I} \gamma^x_{priority} \left[\sum_{v \in villages} \frac{\delta SoL^v_{x,X}}{SoL^v_{x,X}} \Big/ \frac{\delta SoL_x}{SoL_x} \right] \tag{17}$$

$$\epsilon_{normalized} = \frac{\epsilon_{initial} - \epsilon_{\text{max across villages}}}{\epsilon_{max} - \epsilon_{min}} \tag{18}$$

T, Adaptability to Modernization: Technology

$$T = \sum_{x \in I} \gamma^x_{priority}\ \%\text{Adoption} \tag{19}$$

where $\%\text{Adoption} = \frac{\#\text{ strategy implemented}}{\text{total }\#\text{ national strategies}}$

C, Capacity for Innovation

$$C = \sum_{x \in I} \gamma^x_{priority} \left[1 - \gamma^x_{d,M} \frac{\#\text{ strategy imported}}{\text{total }\#\text{ strategies}} - \alpha^x \frac{\#\text{ strategy exported}}{\text{total }\#\text{ strategies}} \right] \tag{20}$$

where α_x = influence coefficient.

K_N, Natural Capital

$$K_N = K_N^{environmental} + K_N^{ecosystem} \tag{21}$$

Normalization scheme:

$$K_N^{normalized} = \frac{K_N^{initial} - K_N^{\text{max across villages}}}{K_N^{max} - K_N^{min}} \tag{22}$$