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S M NAZMUZ SAKIB'S CLIMATE CONFLICT THEORY (CCT): A FORMAL MODEL, EMPIRICAL STRATEGY, AND REAL-WORLD APPLICATIONS

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Abstract

We present a unified, formal statement of S M Nazmuz Sakib's Climate Conflict Theory (CCT). CCT posits that exogenous climate shocks propagate through resource stress, economic pressure, and social grievance channels, moderated by institutions and adaptation, to elevate the risk and intensity of violence. We build a structural, dynamic system capturing (i) climate anomalies, (ii) resource and market responses, (iii) grievance accumulation and mobilization, (iv) spatial diffusion and migration, and (v) policy interventions. We derive comparative statics, sta- bility conditions, and estimable reduced forms (hazard, Poisson, and event-study specifications), and outline an empirical strategy leveraging instruments such as large-scale climate oscillations. Applications (coastal cyclones, Sahel rainfall shocks, and urban heat waves) illustrate how the model guides diagnosis and policy design. Ten original diagrams provide conceptual, network, and risk-surface views, enabling direct implementation in data and simulation.

Keywords: climate shocks; conflict; resource stress; adaptation; institutions; migration; hazard models; event study; instrumental variables; spatial diffusion.

1. INTRODUCTION

SCCT formalizes linkages from climate variability and trends to conflict outcomes. Let regions be indexed by $i \in \{1, \ldots, n\}$ and time by $t \in T \subset N$. Climate exogeneity arises from physics-driven variation (e.g., temperature and precipitation anomalies) that is plausibly orthogonal to short-run local political dynamics. CCT emphasizes three proximate channels: resource stress (R), economic pressure (E), and grievances (G), with two principal moderators: institutions (H) and adaptation (A). Conflict outcomes are encoded in an intensity Y and onset hazard q. This framing builds on and generalizes empirical links between weather/climate variability and social violence documented across multiple contexts [1–5].

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2. CONCEPTUAL GRAPH

Figure 1 depicts the core CCT causal structure.

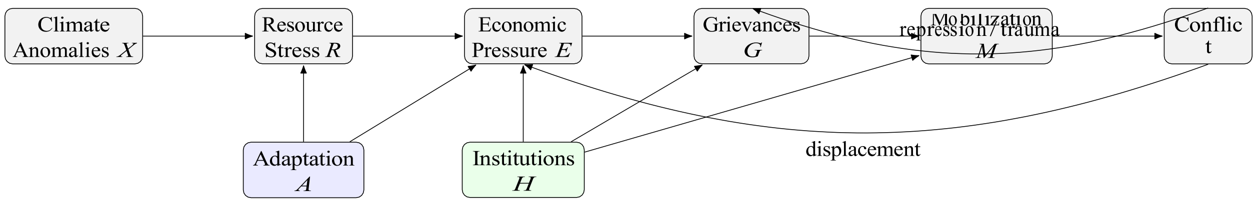

Figure 1: CCT causal diagram: shocks X propagate through R, E, G, and M to conflict Y , moderated by adaptation A and institutions H.

3. MATHEMATICAL MODEL

3.1. PRIMITIVES AND STRUCTURAL CHANNELS

For region i and time t, let the vector of standardized climate anomalies be $X_{it} \in \mathbb{R}^k$ (e.g., tem- perature, precipitation, cyclone exposure, sea-level anomalies). Define resource stress as

$$R_{it} = r(X_{it};\theta_r) - A_{it}, \qquad r(X;\theta_r) := \alpha_0 + \boldsymbol{\alpha}^\top X + \tfrac{1}{2}X^\top \Gamma X. \tag{1}$$

with adaptation effort $A_{it} \geq 0$ (irrigation, storage, insurance, social protection). Economic pressure aggregates market and livelihood impacts:

$$E_{it} = \beta_0 + \beta_R R_{it} + \beta_y(\Delta y_{it}) + \beta_p(\pi_{it}) + \beta_u(u_{it}), \tag{2}$$

where Δy_{it} is income growth, π_{it} food inflation, and u_{it} unemployment or underemployment.

Grievances evolve as a partial-adjustment process:

$$G_{it} = \rho_G G_{i,t-1} + \gamma_E E_{it} + \gamma_I \mathrm{Ineq}_{it} + \gamma_R R_{it} + \varepsilon^G_{it}, \quad |\rho_G| < 1. \tag{3}$$

Mobilization capacity is suppressed by institutions $H_{it} \in [0, 1]$ and aided by opportunity O_{it}:

$$M_{it} = \sigma(\mu_0 + \mu_G G_{it} + \mu_O O_{it} - \mu_H H_{it}), \quad \sigma(z) = \frac{1}{1+e^{-z}}. \tag{4}$$

Conflict intensity follows a spatially-coupled AR(1) with diffusion matrix W (row-stochastic):

$$Y_{it} = \phi Y_{i,t-1} + \lambda M_{it} + \delta \sum_{j\neq i} w_{ij} Y_{jt} + \eta_{it}, \quad |\phi| < 1,\ \delta \in [0, 1). \tag{5}$$

The onset hazard is

$$q_{it} = \sigma(\kappa_0 + \kappa_R R_{it} + \kappa_E E_{it} + \kappa_G G_{it} - \kappa_H H_{it} - \kappa_A A_{it} + \kappa_S S_{it}), \tag{6}$$

with S_{it} state capacity.

3.2. ADAPTATION TECHNOLOGY AND INSTITUTIONS

Let adaptation evolve according to

$$A_{it} = \xi_0 + \xi_H H_{it} + \xi_I I_{it} + \xi_F \mathrm{Fin}_{it} - c_A(I_{it}), \qquad c'_A(\cdot) > 0,\ c''_A(\cdot) \geq 0, \tag{7}$$

where I_{it} is investment, Fin_{it} financial inclusion. Institutions accumulate as

$$H_{it} = \varphi_0 + \varphi_H H_{i,t-1} - \varphi_Y Y_{i,t-1} + \varphi_P \mathrm{Policy}_{it} + v_{it}. \tag{8}$$

3.3. COMPARATIVE STATICS AND STABILITY

Proposition 1 (Direct effects and moderation)**.** *Holding G, E fixed,* $\partial q_{it}/\partial R_{it} = \kappa_R\sigma(1-\sigma) > 0$ *if* $\kappa_R > 0$ *and* $\partial q_{it}/\partial A_{it} = -\kappa_A\sigma(1-\sigma) < 0$ *if* $\kappa_A > 0$. *If A reduces R one-for-one, the total derivative satisfies* $\mathrm{d}q_{it}/\mathrm{d}A_{it} = -\kappa_A + \kappa_R\ \sigma(1-\sigma) < 0$ *when* $\kappa_A, \kappa_R > 0$.

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Proof. Differentiate (6) using the logistic derivative $\sigma'(z) = \sigma(z)(1-\sigma(z))$ and the definition of R.

Proposition 2 (Dynamic stability of conflict intensity)**.** *Under exogenous M and bounded* $\|W\|_\infty \leq 1$, *the linear system* (5) *is mean-square stable if* $|\phi| + \delta < 1$.

Proof. The spectral radius of the state transition operator is bounded by $|\phi| + \delta$ for row-stochastic W; stability follows when this is < 1.

4. EMPIRICAL STRATEGY

4.1. ESTIMABLE SPECIFICATIONS

Hazard model. For time-to-onset T_i, estimate a discrete-time logit with complementary log-log link or logit using (6). Include saturated fixed effects (i, t) and lags of Y.

Intensity model. Estimate

$$Y_{it} = \alpha_i + \tau_t + \phi Y_{i,t-1} + \beta^\top Z_{it} + \delta(WY)_{it} + \varepsilon_{it}, \tag{9}$$

with Z_{it} collecting R, E, G, A, H and controls; WY instrumented by spatial lags of exogenous shocks.

Event study. For shocks at $t = 0$ define leads/lags $\{\ell_k\}$ and estimate $Y_{it} = \alpha_i + \tau_t + \sum_k \theta_k \mathbf{1}\{t - t_{i^\star} = k\} + \epsilon_{it}$ with $k \neq -1$ omitted.

5. IDENTIFICATION

Prior work leverages quasi-random climate oscillations and storm tracks as instruments or natural experiments for climate exposure; we follow similar logic with care for exclusion restrictions [6].

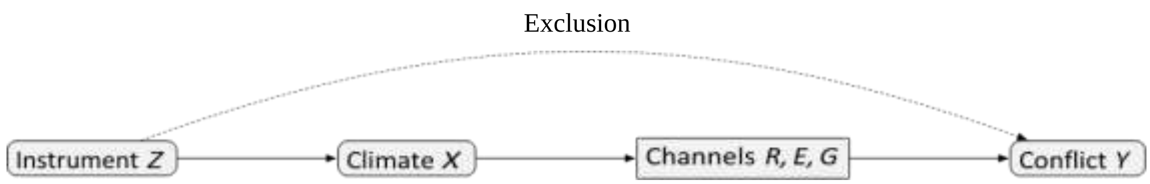

Figure 2: Instrumental-variables identification diagram.

6. APPLICATIONS AND CALIBRATION SKETCHES

6.1. COASTAL CYCLONE EXPOSURE AND LAND-USE CONFLICT

Cyclones raise X_{it} (wind, surge), elevating R via asset loss and salinity intrusion; absent protection A, E spikes through food inflation and job loss. CCT predicts a short-run rise in q and medium-run effects via G unless H and A respond.

6.2. SAHEL RAINFALL DEFICITS AND FARMER–PASTORALIST CLASHES

Rainfall shortfalls (X) depress pasture and yields (higher R), shift prices and grazing patterns (higher E), and amplify disputes over routes and water points (higher G). Mobility management (higher H) and water infrastructure (higher A) flatten the risk surface.

6.3. URBAN HEAT WAVES AND PROTEST

Extreme heat increases R through health stress and productivity loss; power outages intensify E and G. CCT implies peak-day hazard increases that decay as temperatures normalize, moderated by cooling centers (A) and responsive governance (H).

7. POLICY DESIGN AND SIMULATION

Let policy vector Pit shift (A, H) and prices. The marginal risk reduction per dollar (MRRD) for policy p is

$$\mathrm{MRRD}_p = -\frac{\partial q_{it}/\partial P_p}{\mathrm{Cost}_p}. \tag{10}$$

Targeting prioritizes cells with high $\partial q/\partial A$ and low H.

Proposition 3 (Greedy targeting is $1 - 1/e$ optimal). If risk reduction is monotone submodular in selected locations and budget-constrained, a greedy selection of locations by MRRD achieves a $(1 - 1/e)$ approximation to the optimal portfolio.

Proof. Standard submodular maximization under a knapsack constraint.

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8. FIGURES: RISK SURFACES, DYNAMICS, AND DIFFUSION

8.1. Risk surface in (R, H)

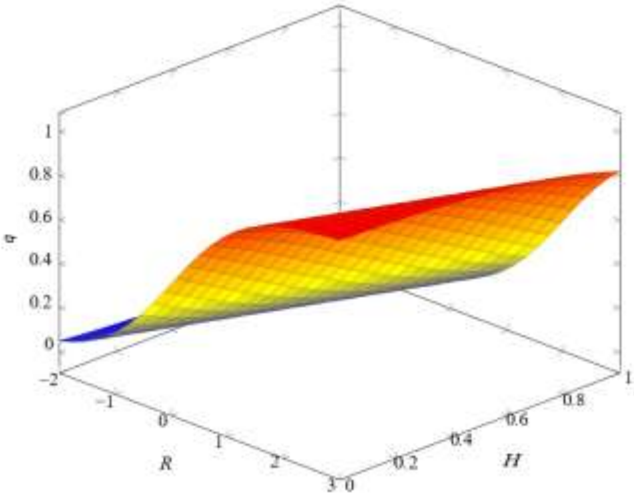

Figure 3: Risk surface $q = \sigma(1.5R - 3H)$. High institutions H flatten risk.

8.2. Phase diagram of conflict dynamics

8.3. Spatial diffusion network

8.4. Event-study visualization

8.5. Baseline hazard shapes

8.6. Migration flows schematic

8.7. Price pass-through from resource stress

8.8. Policy portfolio: efficient frontier

Measurement, data, and implementation notes

- Climate X: Gridded reanalyses or satellite products; construct standardized anomalies (e.g., ERA5, CHIRPS).
- Conflict Y : Event counts/intensity from curated datasets such as ACLED and UCDP-GED; aggregate to region-time [7, 8].

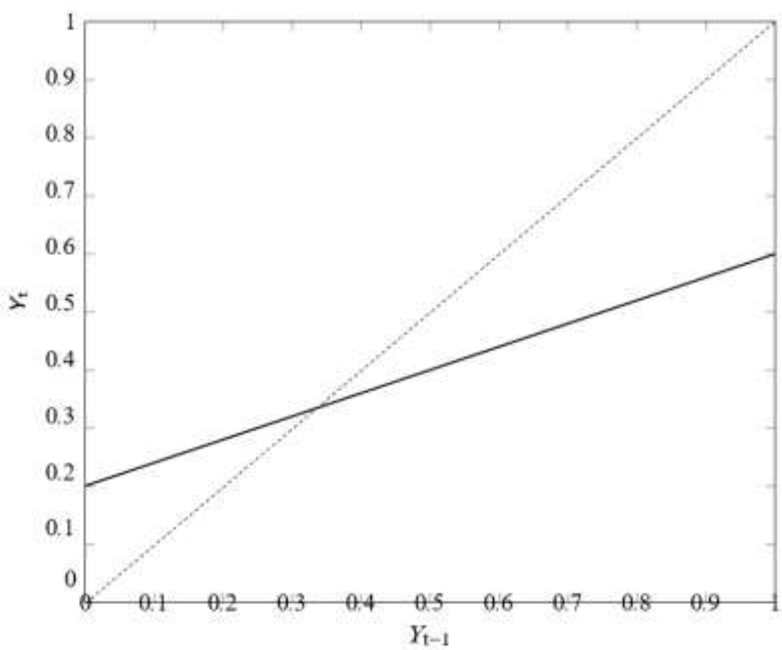

Figure 4: Phase plot of $Y_t = 0.4Y_{t-1} + 0.2$ vs. 45-degree line: stable fixed point at $Y^* = 1/3$.

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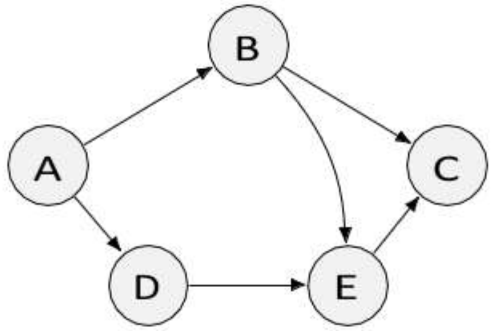

Figure 5: Toy network for diffusion term δWY .

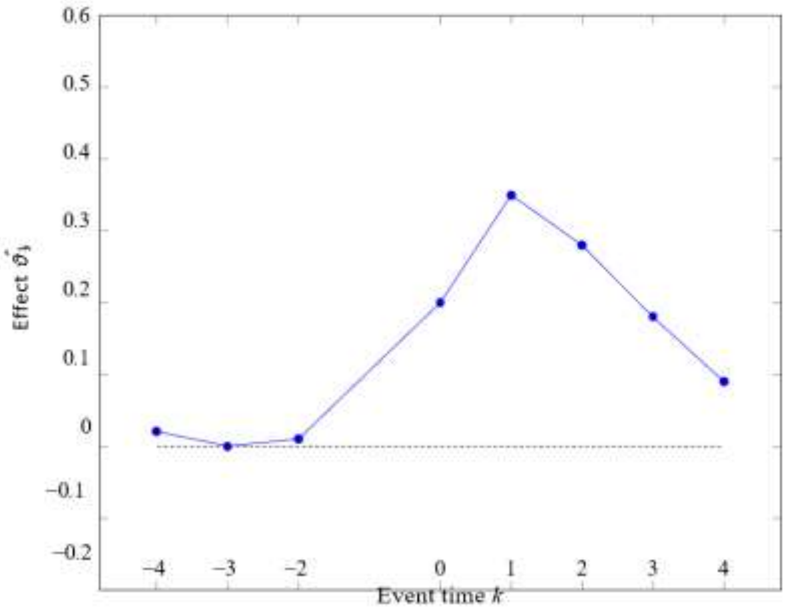

Figure 6: Generic event-study pattern: flat pre-trend, post-shock rise, gradual decay.

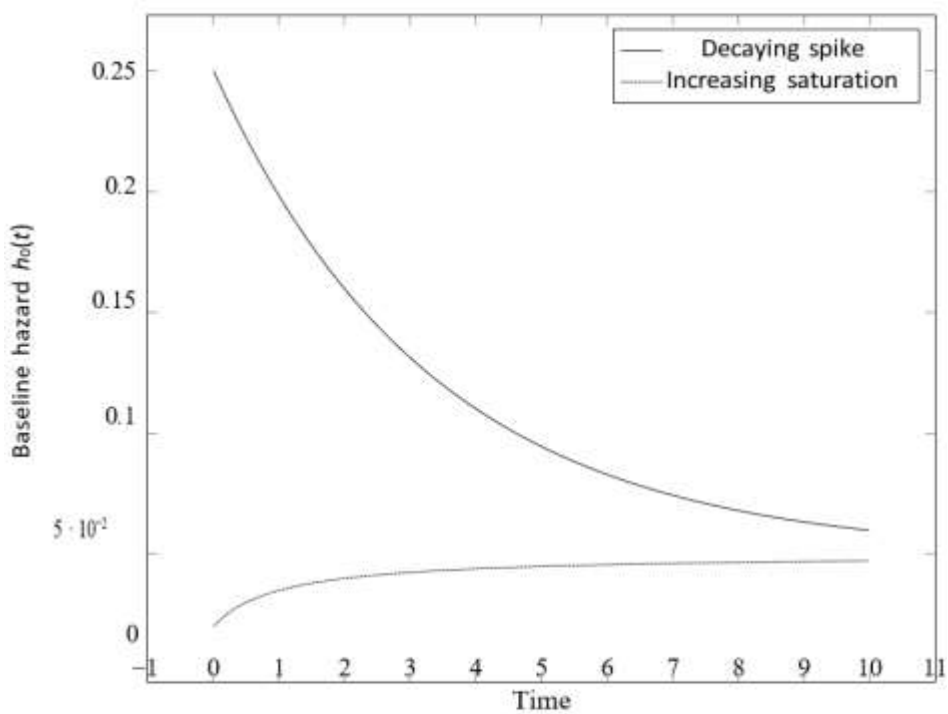

Figure 7: Alternative baseline hazards used in discrete-time models.

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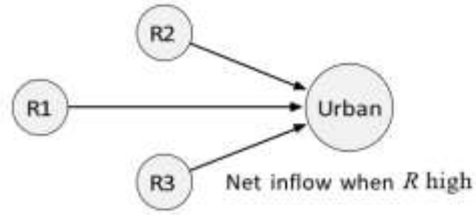

Figure 8: Stylized displacement/migration under high R.

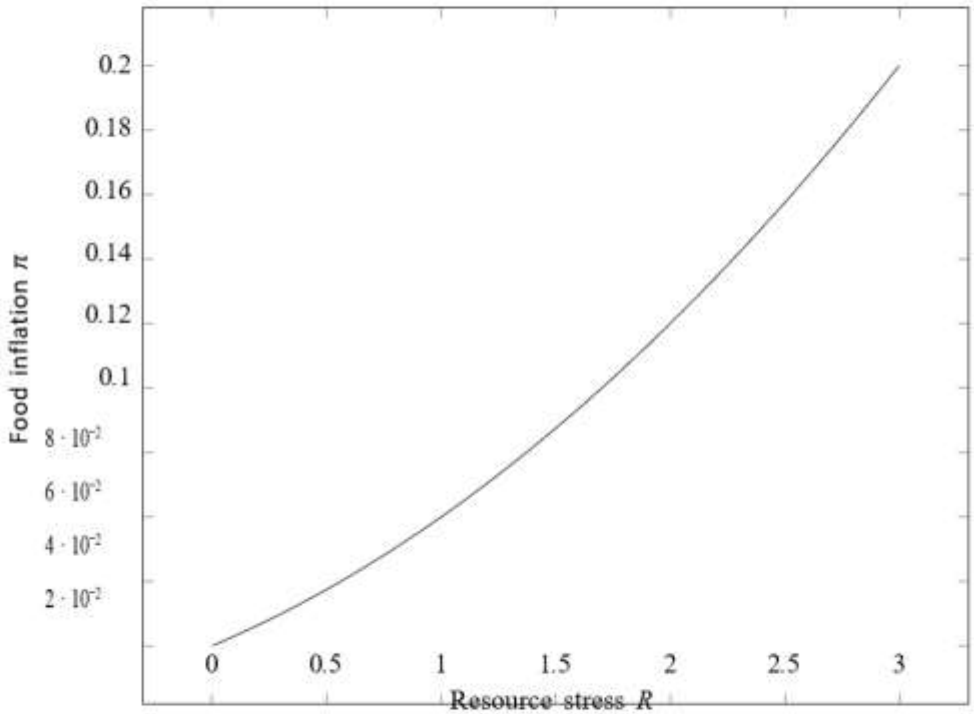

Figure 9: Convex pass-through from R to food inflation π.

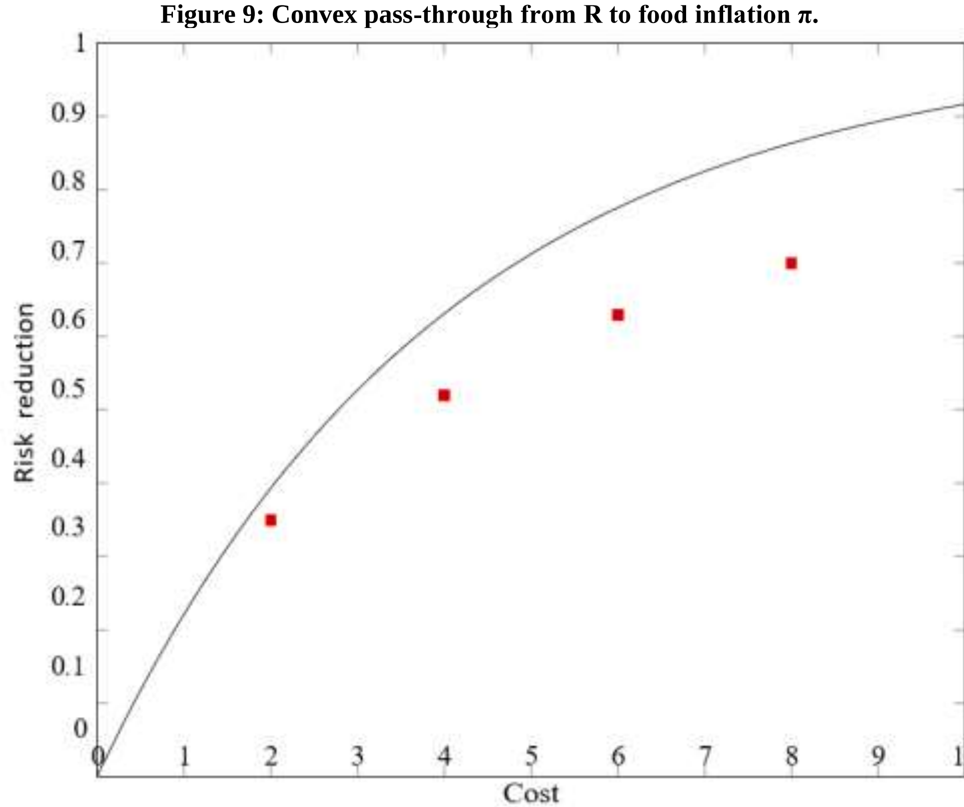

Figure 10: Efficient frontier and example portfolios (marks).

- Institutions H: Subnational governance proxies; normalize to [0, 1].
- Adaptation A: Program coverage, infrastructure indices, or latent factor from multiple indi- cators.
- Estimation: Use clustered standard errors at the regional level; instrument X when necessary.

10. CONCLUSION

CCT offers a tractable, testable bridge between climate physics and conflict science. The for- malization above yields predictions, estimators, and policy levers that can be taken to data and simulation.

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