**How the Research Questions Connect to Form a Unified Research Topic**

The research topic **"Elevation-Driven Changes in Soil Properties, Climate Variability, and Nematode Functional Diversity: Implications for Ecosystem Stability and Carbon Cycling"** is built upon **four interconnected research questions**, each addressing a key ecological process. These questions form a **logical sequence** that explains how **climate, soil properties, nematode communities, and ecosystem functions interact** along elevation gradients.

**🔗 Connection Between Research Questions**

Each question builds upon the previous one to **progressively explore ecosystem dynamics**:

1️⃣ **Climate and Soil Interactions**  
**Q1:** *How do climate variables (temperature, precipitation seasonality, annual range) interact with soil properties (pH, moisture, conductivity, temperature) along elevation gradients?*

* **Foundation:** Climate sets the stage for soil conditions by influencing **moisture availability, acidity (pH), and temperature**.
* **Why It Matters:** Soil properties **directly shape** the **habitat quality for nematodes**, impacting their composition and activity.

⬇️

2️⃣ **Soil and Nematode Community Structure**  
**Q2:** *How do these environmental changes influence nematode trophic structure and functional diversity (e.g., herbivores, bacterivores, fungivores, omnivores, predators)?*

* **How It Connects to Q1:** Changes in soil **pH, moisture, and temperature** impact the distribution of nematode feeding groups.
* **Why It Matters:** The **dominance of certain nematode groups** (e.g., fungivores vs. bacterivores) provides insights into **decomposition pathways and nutrient cycling**.

⬇️

3️⃣ **Ecosystem Stability & Soil Functional Indices**  
**Q3:** *What is the role of soil maturity indices (Sigma Maturity Index, Enrichment Footprint, Composite Footprint, Channel Index) in predicting ecosystem responses?*

* **How It Connects to Q2:** Functional indices reflect the **degree of ecosystem stability**, **resilience to environmental change**, and the balance between **opportunistic (colonizer) vs. stress-tolerant (persister) nematodes**.
* **Why It Matters:** These indices **summarize the overall ecosystem condition**, indicating whether climate and soil changes lead to **sustainable or degraded environments**.

⬇️

4️⃣ **Nematodes, Carbon Cycling & Nutrient Turnover**  
**Q4:** *How do changes in plant-parasitic nematodes (PP 2-5) and free-living nematodes (CP 1-5) affect belowground nutrient cycling and carbon flux?*

* **How It Connects to Q3:** If nematode diversity and functional stability shift, this will alter **carbon sequestration, decomposition rates, and nutrient cycling efficiency**.
* **Why It Matters:** This question **completes the research framework** by linking environmental shifts (climate → soil → nematodes) to **ecosystem-level processes like carbon and energy flow**.

**🔬 How These Questions Create a Unified Research Topic**

**📌 Core Theme:**

**"How do elevation-driven climate and soil changes affect nematode biodiversity, ecosystem stability, and carbon cycling?"**

**🌿 Logical Flow of the Study:**

✅ **Climate shapes soil properties** → ✅ **Soil properties determine nematode diversity** → ✅ **Nematode diversity reflects ecosystem stability** → ✅ **Ecosystem stability influences carbon cycling**

This stepwise approach ensures a **holistic understanding** of how **soil biodiversity, climate change, and ecosystem processes interact**, making it a **comprehensive research direction**.

**Key Word:**

precipitation seasonality

The Coefficient of Variation is the standard deviation of the monthly precipitation estimates expressed as a percentage of the mean of those estimates (i.e. the annual mean)

1. Climate and Soil

**Strong Positive Correlations**

* **Temperature vs. Temperature Annual Range (0.89)**
  + **Higher soil temperatures are associated with greater temperature variability.**
  + Possible explanation: **Areas with higher temperature annual range experience more pronounced seasonal soil temperature shifts.**
* **Precipitation Seasonality vs. Temperature (0.75)**
  + **Soils in areas with strong seasonal rainfall variation tend to be warmer.**
  + Possible explanation: Wet-dry cycles influence **heat retention in soils**, altering microbial activity and decomposition rates.
* **Conductivity vs. Temperature Annual Range (0.88)**
  + **More extreme temperature variations correlate with higher soil conductivity.**
  + Possible explanation: **Freeze-thaw or dry-wet cycles** may **concentrate salts and minerals in the soil**, increasing conductivity.

**🔹 Strong Negative Correlations**

* **Soil Moisture vs. Soil Temperature (-0.94)**
  + **Drier soils tend to be warmer, and wetter soils tend to be cooler.**
  + Possible explanation: **Higher soil moisture buffers temperature fluctuations, preventing extreme heating or cooling.**
* **Soil Moisture vs. Temperature Annual Range (-0.89)**
  + **Greater temperature fluctuations are linked to lower soil moisture.**
  + Possible explanation: Repeated **evaporation cycles in dry environments** lead to **moisture loss over time.**
* **Soil Moisture vs. Conductivity (-0.82)**
  + **Drier soils tend to have higher conductivity.**
  + Possible explanation: **Lower moisture reduces dilution of dissolved salts**, leading to increased conductivity in arid environments.