

# Methodological perspectives on the application of compound-specific stable isotope fingerprinting for sediment source apportionment

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## Abstract

**Purpose** Compound-specific stable isotope (CSSI) fingerprinting of sediment sources is a recently introduced tool to overcome some limitations of conventional approaches for sediment source apportionment. The technique uses the <sup>13</sup>C CSSI signature of plant-derived fatty acids ( $\delta^{13}\text{C}$ -fatty acids) associated with soil minerals as a tracer. This paper provides methodological perspectives to advance the use of CSSI fingerprinting in combination with stable isotope mixing models (SIMMs) to apportion the relative contributions of different sediment sources (i.e. land uses) to sediments.

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**Results and discussion** CSSI fingerprinting allows quantitative estimation of the relative contribution of sediment sources within a catchment at a spatio-temporal resolution, taking into account the following approaches. First, application of CSSI fingerprinting techniques to complex catchments presents particular challenges and calls for well-designed sampling strategies and data handling. Hereby, it is essential to balance the effort required for representative sample collection and analysis against the need to accurately quantify the variability within the system. Second, robustness of the CSSI approach depends on the specificity and conservativeness of the  $\delta^{13}\text{C}$ -FA fingerprint. Therefore, saturated long-chain (>20 carbon atoms) FAs, which are biosynthesised exclusively by higher plants and are more stable than the more commonly used short-chain FAs, should be used. Third, given that FA concentrations can vary largely between sources, concentration-dependent SIMMs that are also able to incorporate  $\delta^{13}\text{C}$ -FA variability should be standard operation procedures to correctly assess the contribution of sediment sources via SIMMs.

**Conclusions** This paper reflects on the use of  $\delta^{13}\text{C}$ -FAs in erosion studies and provides recommendations for its application. We strongly advise the use of saturated long-chain (>20 carbon atoms) FAs as tracers and concentration-dependent Bayesian SIMMs. We anticipate progress in CSSI sediment fingerprinting from two current developments: (i) development of hierarchical Bayesian SIMMs to better address catchment complexity and (ii) incorporation of dual isotope approaches ( $\delta^{13}\text{C}$ - and  $\delta^2\text{H}$ -FA) to improve estimates of sediment sources.

**Keywords** Biotracers · Compound-specific stable isotope (CSSI) analysis · Erosion · Fatty acids (FAs) · Sediment fingerprinting · Stable isotope mixing models (SIMMs)

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## **Table of Contents Application And Methodological Perspectives In**

1. Understanding the eBook Application And Methodological Perspectives In
  - The Rise of Digital Reading Application And Methodological Perspectives In
  - Advantages of eBooks Over Traditional Books
2. Identifying Application And Methodological Perspectives In
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Application And Methodological Perspectives In
  - User-Friendly Interface
4. Exploring eBook Recommendations from Application And Methodological Perspectives In
  - Personalized Recommendations
  - Application And Methodological Perspectives In User Reviews and Ratings
  - Application And Methodological Perspectives In and Bestseller Lists
5. Accessing Application And Methodological Perspectives In Free and Paid eBooks
  - Application And Methodological Perspectives In Public Domain eBooks
  - Application And Methodological Perspectives In eBook Subscription Services
  - Application And Methodological Perspectives In Budget-Friendly Options

6. Navigating Application And Methodological Perspectives In eBook Formats
  - ePub, PDF, MOBI, and More
  - Application And Methodological Perspectives In Compatibility with Devices
  - Application And Methodological Perspectives In Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Application And Methodological Perspectives In
  - Highlighting and Note-Taking Application And Methodological Perspectives In
  - Interactive Elements Application And Methodological Perspectives In
8. Staying Engaged with Application And Methodological Perspectives In
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Application And Methodological Perspectives In
9. Balancing eBooks and Physical Books Application And Methodological Perspectives In
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Application And Methodological Perspectives In
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Application And Methodological Perspectives In
  - Setting Reading Goals Application And Methodological Perspectives In
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Application And Methodological Perspectives In
  - Fact-Checking eBook Content of Application And Methodological Perspectives In
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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